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Threats Without Threateners?

Exploring Intersections of Threats to the Global Commons and National Security

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Preface

This think piece was sponsored by the Skoll Global Threats Fund, whose mission is to "confront global threats imperiling humanity by seeking solutions, strengthening alliances, and spurring the actions needed to safeguard the future." In particular, the Fund focuses on five threats that, if not all fully global, do require multiple parties to participate in addressing them: nuclear proliferation, Middle East conflict, climate change, water scarcity, and pandemics. In contrast to the established significance of nuclear proliferation and Middle East conflict, the relevance of the other three threats to national security remains less examined.

To explore whether it might lead to different perspectives in approaching these issues, this paper looks at climate change, water scarcity, and pandemics as global issues with potential public "bads." It also looks into the national security dimensions of these three issues and how they are related—their similarities and differences, and their interconnections—focusing on the commonalities that make them difficult to address. It then reviews what might be called the "usual" approaches to such problems, examining why several have not worked well so far. The implicit conclusion: without some novel approaches, these global threats will persist.

The paper then asks the reader to consider some different approaches illustrated through suggestive cases intended to make each type of approach more concrete. This aims to inspire ways of thinking about new policy approaches, not to suggest that they amount to "the solution." Nor does this think piece present a thorough review of what is possible. Rather, the idea is to advance a conversation, ideally one across disciplines and perspectives, to help readers become more creative about the possibilities for action, not only by governments but also by business, civil society, and organizations like the Skoll Global Threats Fund. It is to individuals in such institutions, as well as to other thought leaders and interested citizens, that this paper is addressed. And though we write from a U.S. perspective and are ultimately most concerned with U.S. national security, the threats covered are global or at least regional, so we seek to engage readers beyond U.S. borders.

The research was conducted by RAND's Center for Global Risk and Security. The mission of the Center is to support innovative, crosscutting work on important issues of national security (broadly defined), issues that may be a little over the horizon, those that cut across government stovepipes in a way that leaves no agency in charge, or those that simply lack for existing sponsors. The Center's criteria for seeking research are, first, that the issue is important and, second, that RAND's breadth—from strategy to health care, from technology to demographics—as well as its depth provide conceptual purchase. In that sense, this paper represents the happy congruence between the mission of the Skoll Global Threat Fund and that of the Center.

The Center for Global Risk and Security is one of several within RAND's International Programs, which also include the Center for Asia Pacific Policy, the Center for Middle East Public Policy, the Center for Russia and Eurasia, and the Pardee Center for Longer Range Global Policy and the Future Human Condition.

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Contents

Figures

Tables

Summary

Could three global issues—climate change, water scarcity, and pandemics—be posed as national security challenges with interconnected threats to the global "commons"?[1] And, if so, could this perspective help trigger new approaches for addressing them? For the United States, impacts on national security are important but mostly indirect, resulting from the ripple effects of direct impacts on other countries and regions, especially poor ones. This paper explores the interconnections of these issues and discusses a range of policy ideas: not to recommend them as "solutions," but to stimulate an alternative way of thinking about policy—one that might be characterized as indirect, not direct; bottom-up, not top down; and opening new possibilities, not "fixing" the problem.

Parsing the Issues

The three issues are, in different degrees, globalized in that they respect no national borders. They are social in the sense that individuals, acting in their own interest, generate negative effects on the commons. This is true whether people release carbon into the atmosphere, use water, or simply enjoy the benefits of rapid travel by air. In that sense, if they can be regarded as global threats, they are "threats without threateners."

The risks of all three are hard to assess, and thus building coalitions for action is difficult. Climate change, especially, is chronic, not acute, so inaction today carries little immediate cost.[2] Water scarcity is similar, and while a future pandemic may be virtually certain, its timing and severity are not. Policies to address the three require current investments for future and, in some cases, uncertain gains. In that sense, to the extent that they are commons problems, all three are beset by "free-riding." Free-riding is most visible in regard to climate change because all nations would like to reduce global carbon emissions, but many would prefer that other nations actually undertake the reductions.

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[1]   "Commons" derives from the old English commons—that is, grazing land jointly owned by a village and thus a public good. Absent some regulation or division into private patches, each villager had an incentive to graze one more animal, then another, and so on. Since the incentives were the same for all villagers, the result was overgrazing of the commons. The term has been extended to a wide range of public policy problems in which the self-interested decisions of individuals, made separately, combine to damage interests they hold in common—producing what are sometimes called public "bads." Here, the commons is used as a metaphor for that category of policy problems. The classic article is "The Tragedy of the Commons" by Garrett Hardin (1968).

[2]   To the extent that extreme weather events predicted by the climate-change models—heat waves, floods, droughts—are plausibly connected to global warming, those acute episodes will diminish the chronic (i.e., future worry) perception of climate change.

The connection between climate change (or global warming) and safe water is plain to see. Climate change increases the risk of both regional water scarcity and flooding, which reduces safe water supplies. Limited supplies of safe water in turn increase vulnerability to purposeful contamination and might facilitate natural spread of diseases. Cholera, for instance, is linked to unsafe water.[3] Migration is a key connection among the three. Again, that connection is most clear regarding water scarcity, where migration driven by the search for water already has been a source of conflict when areas to which the water-hungry migrate are unprepared or unwilling to accept them. Climate change will touch off migration both as water becomes locally scarce, as sea levels rise, or as the climate becomes uninhabitable due to extreme heat or cold.

Disease, too, might set off movements of people, and such movements, however caused, might also touch off disease, exporting diseases to places that did not previously have them—a version of the fate that befell the native populations in the Americas when European colonizers arrived.

Yet the differences among the three issues are also critical in conceiving policy. Climate change was immediately recognized as an issue of the global commons, while pandemics have only recently come to be thought of in that way—despite the devastating experience of 1918. Pandemics, as well as water scarcity, contrast with climate change in that they could result either from Mother Nature or from a malevolent foe. All three can be viewed as global, but effects will be felt and policies framed nationally and regionally, especially for water. The three also differ in how susceptible they are to unilateral actions, especially by the United States. Purely national measures offer the most benefits in dealing with pandemics; less so for the other two.

Conceiving Alternative Policy Approaches

Looking at specific cases that illustrate current principal policy approaches to the three issues provides a starting point for assessing the need for alternatives. For pandemics, international cooperation has been increasing; in two recent major disease outbreaks—severe acute respiratory syndrome (SARS) and H1N1 influenza—the world has had the good luck to "practice" cooperation on viruses that were neither very contagious nor very lethal. To deal with the security consequences of conflict driven at least in part by water scarcity, two principal international instruments have been used: negotiations among river basin countries and ad hoc responses by coalitions of the willing. For climate change, the foremost international instrument—broad, formal negotiations in the Kyoto Protocol under the U.N. Framework Convention on Climate Change (UNFCCC)—has not worked. The main reason is that the arguments made by poorer countries for free-riding ("You rich countries got rich by emitting carbon and now you're trying to deny us that path") give license to other countries, like the United States, to opt out as well. Although not intended to be a rigorous assessment of policy success or failure, this paper's review of current approaches raises enough questions to suggest the value of considering alternatives.

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3   For links between cholera outbreaks and scarcity of safe water, see, Dasgupta (2010) and Holmner and others 2010, and for modeling of the spread of plague according to different scenarios of climate change, see Holt and others (2009).

In conceiving such alternatives, policy approaches to the three issues can be thought of in four overlapping clusters, roughly along continuums from centralized to decentralized; from government dominated to private-sector driven; from regulating to enabling; and from "fixing" to adapting. Figure S.1 depicts the four across the spectrums of approaches to policy and solutions.

The first two, international negotiations and coalitions of the willing, are familiar, and so is the third—transcommunity networking—though it has been dramatically enhanced by new information technology and experience. The fourth cluster—anti-fragile approaches—requires more explanation.

1. **International Negotiations.** Kyoto failed to reduce global carbon emissions mostly because the free-rider problem was insoluble. However, formal negotiations require nations to say "yes" or "no." Forced to do so, China had to say no. Yet the real Chinese answer is not "no," rather "yes, but in our own way" (National Development Reform Commission, 2009). China knows that its current consumption of fossil fuel, especially coal, will bring short-term riches only at the price of long-run ruin of its own environment. That recognition is demonstrated by China's aggressive alternative energy programs even as it continues to build new coal plants.

2. **Coalitions of the Willing.** In effect, Kyoto drifted to a coalition of the willing. A fairly effective coalition of the willing was demonstrated in the international cooperation that

Figure S.1
Four Clusters of Approaches to Policy and Solutions
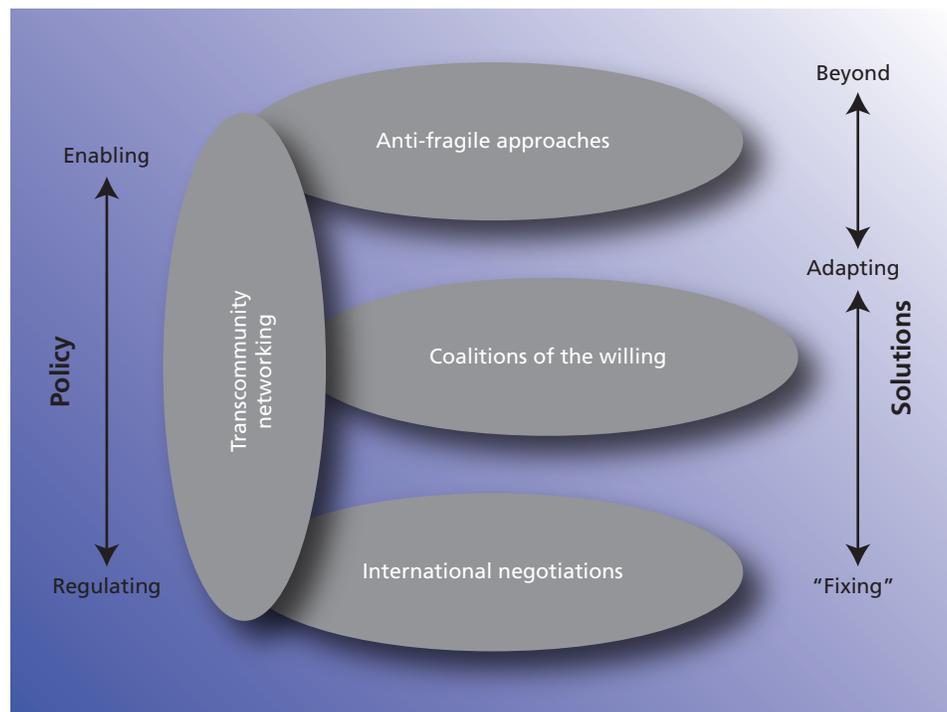
dealt with the SARS outbreak; the World Health Organization (WHO) and national health authorities provided some infrastructure and the coalition worked well because national interests were aligned, in general, with shared international ones.

3. **Trans-community networking.** This cluster might be better regarded as a facilitator for the other three more than as an approach in its own right. Web-based social networking provides a virtual platform in which best practices can be shared and transnational coalitions of the willing can form. This approach is particularly applicable for all three threats because they all involve deeply uncertain events and affect multiple tiers within society. For example, information sharing must be a key component of any discussion of global preparedness for pandemics.

4. **Anti-fragile approaches.** For Nassim Taleb, statistician and author of *The Black Swan*, language that uses "robust" or "unbreakable" to describe the opposite of "fragile" is wrong. Rather, objects that are the opposite of fragile would be ones that *benefit* from shocks that would destroy fragile things—thus "anti-fragile." When antibiotics do not kill bacteria colonies, for instance, they make them stronger as resistant strains survive and multiply. Just as nothing is perfectly fragile, nothing is perfectly anti-fragile; the antibiotics could still kill the bacteria. Being open to anti-fragile logic serves as an antidote to what seems a deeply rooted human tendency to want to "fix" a problem (even one as big as climate change) much as we "fix" a broken plate—returning it as close to its previous state as possible. Kyoto sought to "fix" climate change by stabilizing greenhouse gas (GHG) emissions. It failed in that purpose—emissions increased by a quarter in the first eight years after its signing—largely because its logic fell prey to the free rider problem.

From "Fixing" to Adapting and Beyond

Anti-fragile systems do not just cope with challenges or mistakes; they learn from them. From the perspective of problems of the commons, an anti-fragile approach would be "adapting-plus": it would search for alternatives that could attract new participants, scale to accommodate those new participants, and then perform as well or better than the legacy system. The approach would create a positive feedback loop, one continually improving the system as time passed and the legacy system suffered more disruptions.

Figure S.1 introduced three of the clusters as relatively discrete and suggested a linear progression from regulating to enabling and from "fixing" a problem to adapting to the consequences of a threat. As depicted in Figure S.2, policy approaches are more likely to evolve through an interplay of familiar and more novel approaches. The axes represent increasing autonomy of solutions and an increasing connectivity among participants who implement them. Somewhat counterintuitively, the combination of autonomy and connectivity can foster an evolution from policy that imposes regulations to policy that enables innovative solutions.

For water scarcity, an idea as simple as collecting rainwater meets some anti-fragility criteria. It can scale because individuals can opt in at any time without more infrastructure or placing demands on the system (i.e., my decision to start collecting rainwater does not infringe on your ability to do so). Up to a point, the scheme is encouraged by shortages in water supply

Figure S.2
Evolution of Four Approaches to Policy

Accessibility of technology expands the pool of participants who create innovative solutions

Enabling policy

Beyond

Anti-fragile approaches

Coalitions of the willing

Transcommunity networking

Adaptive solutions

International negotiations

"Fix it"

A shift to autonomous solutions leads to cooperative policy

Regulatory policy

Connectivity of participants

Autonomy of users
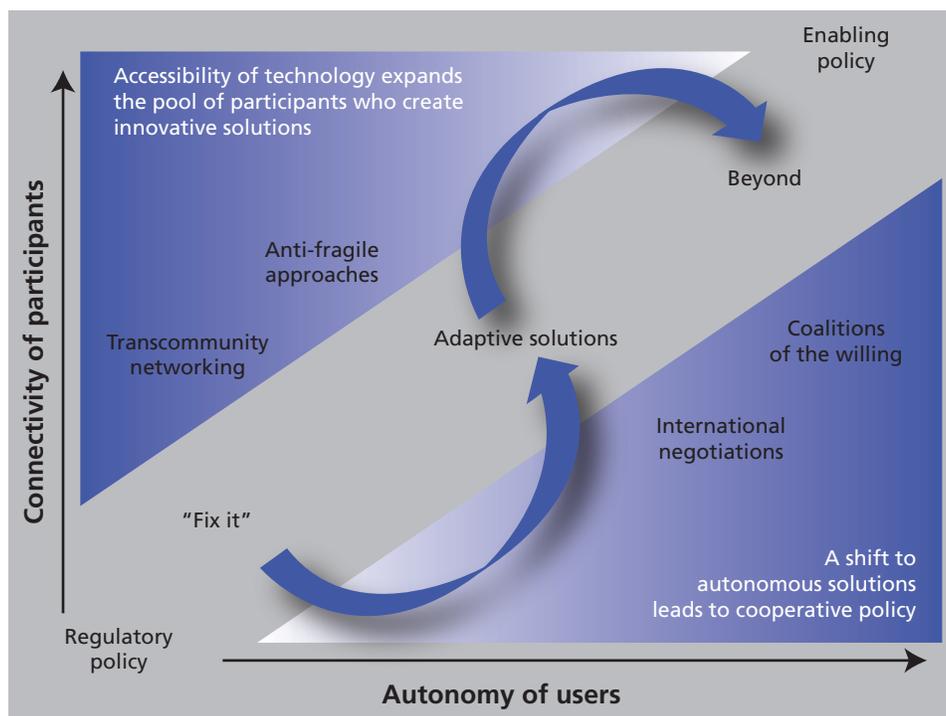
systems. Disruption may also inspire the development of innovative, sustainable technologies such as collecting water from fog in arid regions.[4]

For pandemics, detection represents an aspect of anti-fragility. Techniques that enable detection despite political concerns and social stigma contribute to an anti-fragile approach. For example, smart phones and social networking provide a medium through which health care professionals could spontaneously serve as collectors of intelligence on the spread of a disease.

Regarding climate change, potential policy steps beyond Kyoto-as-a-coalition-of-the-willing include adapting—for instance, building dikes or changing to water-frugal crops—or geoengineering to reduce either atmospheric carbon or solar radiation. However, neither approach is anti-fragile, and only adapting broaches the premise that the previous status quo is beyond recovery. By contrast, four other ideas with anti-fragile characteristics suggest an alternative, indirect view of policy. All could have the side effect of reducing carbon emissions. They do not provide a "Solution" with a capital "S" to the challenge, primarily for reasons of ability to scale, but are meant to be illustrative.

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[4]   A technology that mimics the mechanism of the Namib beetle for collecting moisture from fog may help with water collection in mountainous regions and deserts distant from water sources (see "Water Good Idea," 2011).

- **Local fabrication using three-dimensional printing.** Three separate strains of customized production methods—rapid prototyping machines, numerical control systems, and personal three-dimensional printers—offer the promise of manufacturing done locally, on demand. Local fabrication of a range of items could attract new participants, enabling them not only to survive shocks to the legacy production system but actually get stronger by selling their neighbors products made locally. It is hard to be categorical about the net effect on carbon emissions, for that depends on factors such as the energy required to transport raw materials and the emissions of local production in comparison to traditional manufacturing, but the best estimates thus far are positive.
- **Local smart grids and local power production.** Individual households would generate some of their own power through rooftop solar panels or micro wind turbines. They would then share unused power over a neighborhood smart grid that could operate autonomously during national grid disruptions or as part of the national grid on a day-to-day basis. Participants in this local electrical power generation platform would be positioned to survive during shocks to the fragile legacy system.
- **"Passive house" design standards.** This focuses on maximizing efficiency of a system as a whole, instead of suboptimizing components of the system. The American environmental scientist and writer Amory Lovins has pointed out that the logic that energy efficiency improvements have decreasing marginal returns fails to hold if houses can be insulated so well that they no longer need a central heating or cooling source by using what are called "passive house" design standards. The long-term cost savings from neither having a furnace nor needing fuel might dwarf the upfront costs of super-efficient insulation and windows.
- **Resilient communities.** Each of the previous ideas is suggestive, but putting them together not only might produce reductions in GHG emissions but also improve resilience to natural disasters, terrorist attacks, and financial crises. For example, local fabrication would mean that some replacement parts for a wind turbine could be locally produced in an emergency. Communities composed of radically efficient homes built or renovated using passive house design principles would require significantly less energy than legacy homes, reducing the amount of local power required to meet these needs, freeing power to be used for public services, or for sale outside the community.

Notice that this alternative approach to policy is worth considering whether or not the issues are regarded as ones of national security. What the national security dimension adds to these three issues is a sense of urgency to thinking of new ways to address them. While "national security" usually implies top-down action, for alternative approaches the government becomes the enabler, not the enactor. Its role becomes one of adjusting regulations that stand in the way of alternatives, and tempering the force of lobbies wedded to legacy approaches.

Acknowledgments

Abbreviations

CAD	computer-aided design
CDR	carbon dioxide removal—methods for extracting carbon from the atmosphere and storing it
CFC	chlorofluorocarbon—a chemical whose release depletes the ozone layer; an ODC
GHG	greenhouse gas—contributes to global warming
GOARN	Global Outbreak and Alert Response Network; coordinated by WHO
HCFC	hydrochlorofluorocarbon—a chemical less harmful to the ozone layer than a CFC
HFC	hydrofluorocarbon—a chemical less harmful to the ozone layer than an HCFC
IPCC	Intergovernmental Panel on Climate Change
MTC	Mobile Technology Complex—a portable parts fabrication system to create replacement parts using basic raw materials and CAD
ODC	ozone-depleting chemical
SARS	severe acute respiratory syndrome
SOCOM	U.S. Special Operations Command
SRM	solar radiation management—techniques for reflecting sunlight back into space to reduce global warming
UNFCCC	U.N. Framework Convention on Climate Change
WHO	World Health Organization
WMD	weapon of mass destruction; can be nuclear, chemical, or biological

Introduction

In determining its five priority issues—nuclear proliferation, conflict in the greater Middle East, water scarcity, pandemics, and climate change—the Skoll Global Threats Fund gave special weight to two criteria. The first is *importance of the threat*. In current circumstances, only pandemics seem to be an existential threat, capable of destroying America's way of life. However, it is easy to imagine scenarios under which the nuclear issue, an existential threat during the Cold War, would be regarded as such again. The second criterion is the *need for collective action*. All five priority issues, including Middle East conflict, require many parties to participate to produce a solution, and at least two, pandemics and climate change, are truly global in scope.[1]

This think piece asks to what extent three of the five—climate change, water scarcity, and pandemics—can be regarded as national security challenges and as threats to the global "commons." "Commons" derives from the old English commons—that is, grazing land jointly owned by a village and thus deemed a public good. Absent regulation, privatization, or strong social norms, each villager had an incentive to graze one more animal, then another, and so on. Since the incentive was the same for all villagers, the result was overgrazing of the commons. The term has been extended to a wide range of public policy problems in which the self-interested decisions of individuals, made separately, combine to damage interests they hold in common—producing what are sometimes called public "bads." Here, it is used as a metaphor for that category of policy problems.

This paper explores the three issues of climate change, water scarcity, and pandemics—first, to what extent they could pose national security threats, and second, what differentiates and connects them, in both effects and in policy responses. The three issues tend to be treated as discrete with their own specialists, literature, policies and policy makers; yet the purpose here is to provoke thought about relevant policy approaches as they intersect, broadening the discussion of the three. Although the paper discusses specific policy ideas, they are presented simply to help explain the approaches through illustration; there is no implication that they constitute *the* solution to the problem.

These three issues demonstrate the varying ways in which globalization, while delivering major benefits for development via economic growth and improved connectivity worldwide, also has accelerated a series of global challenges. Economic growth has lifted millions out of poverty in China, India, and elsewhere, yet it has also exacerbated climate change. Economic growth also puts increasing strains on resources, including water, as agriculture and industrial

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[1]   Based on 2008 data from the U.S. Department of Energy's Carbon Dioxide Information Analysis Center (cdiac.ornl. gov), the three largest carbon emitters—China, the United States, and the European Union—account for more than half the global total. Adding India, Russia, and Japan accounts for about 70 percent of the total.

processes expand. Increased travel has opened new opportunities but also cleared paths for diseases to spread more rapidly, perhaps triggered or accelerated as increased crowding produces more contact between humans and animals.

The relevant time horizons depend to some extent on the issue at hand. Pandemics are a real possibility in the here and now; there is nothing future about them. So, too, conflict related to water scarcity already confronts us. For both issues (or threats), the questions for the future are how much worse will the problems get, and, in particular, can policy responses keep up with their progression, and if so, how? Some manifestations of climate change may already be with us, although the scientific projections often look out as much as a century. In any case, people act in the shadow of expectations; they will migrate from low-lying areas before their feet get wet.

This think piece is organized into three sections. First, Chapter Two probes the three issues by describing them and assessing their national security implications. Then Chapter Three examines the connections and differences between them. It looks selectively at specific cases to distill past policy approaches that have been employed to address big problems that require multilateral solutions but face the risk of "free-riding."[2]

In Chapter Four, the paper shifts gears and becomes more conjectural to provoke creative thought about new approaches and solutions. It begins by laying out four clusters of policy approaches, ranging from the most familiar to those that are less so. Then examples of policy ideas are presented to illustrate the four clusters of approaches, concentrating on the two less familiar clusters. Again, the point is to stretch thinking about policy in general and policy toward these three issues in particular, not to argue that the specific ideas are parts of "the solution," or ones that could be scaled up soon. As the least global of the three, water scarcity was particularly challenging to examine. Yet some of the policy approaches outlined here can be applied across all three threats to the global commons, including water scarcity, to spur thinking about new ways to attack them.

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[2]   Free-riding is most obvious in regard to climate change. It arises because all nations would like to reduce global carbon emissions, but each nation would prefer that other nations actually undertake the reductions. Thus, they are all tempted to be free riders.

Exploring Three Threats Without Threateners

Do climate change, water scarcity, and pandemics pose challenges to national security? In general, they do, but from the perspective of the United States (and other rich countries), the challenges are mostly indirect; they are the spillover of direct problems in poorer countries. This section begins with descriptions of the three issues and their national security implications, then turns to the think piece's premise: is there value from a policy perspective in thinking of the three as interconnected? This section sketches the connections among these issues—the implications of climate change for water scarcity is the most obvious example—and concludes with their differences.

The Issues from a National Security Perspective

Table 2.1 summarizes some of the differences between Cold War and current definitions of national security from the perspective of the United States. It drives home how different from

Table 2.1
Changing U.S. Perceptions of "Security"

	Cold War Definition	Current Definition
What is the threat?	Primarily states, secondarily nonstates	Primarily nonstates or failed states, as well as states; also "threats" from disease, financial contagion, oil supply disruption, water scarcity
Where is the threat?	Abroad	Abroad and at home
What is the ranking of threats?	WMD in hands of states, major conventional warfare between East and West	Pandemic, WMD in hands of nonstates and states; other forms of terror
What policy instruments are available?	Primarily military, though diplomacy and foreign aid also relevant	Very wide range, not all in hands of government; military, homeland security, diplomacy, international assistance and engagement of various sorts, as well as "soft power"; private initiative
How key are allies, partners?	NATO and Warsaw Pact, but much of policy was unilateral (U.S., USSR)	Inherently multilateral, well beyond military alliances
How much are ordinary citizens affected?	Not much; citizens paid taxes, felt "nuclear threat," but security was the business of the military	Much more; citizens affected by security measures or burning less carbon; many levels of government involved, also business and civil society

NOTE: WMD = weapon of mass destruction.

past threats the three issues are as matters of national security. While pandemics top the list of threats—killing one quarter of Americans would not finish off U.S. society but would change it beyond recognition—even pandemics could occur without an adversary. In contrast to the Cold War, military measures are relevant only to one of the issues, water scarcity, and then only once scarcity has led to conflict. All three of the issues are inherently multilateral; indeed, for only one (pandemics) could purely national measures make much of a difference.

Climate Change

Climate change and its effects on human society might be thought of in three orders. The first is direct change in mean surface temperature and, perhaps more important, in weather patterns producing more extreme events. The second is climate change's impact on such critical human factors as water, agriculture, and disease (Intergovernmental Panel on Climate Change, 2007).[1] These first and second order effects will drive human responses, producing third-order effects—social, political, economic, and institutional changes—that in turn will affect the regional and international economic and security environment. It is these second- and third-order effects that drive national security concerns (Busby, 2007; CNA Corporation, 2007; U.S. Congress, 2008).

As is the case for water scarcity, the security issues driven by climate change will emanate mostly from poor countries. At home, the United States will confront economic issues as rainfall becomes more variable and dislocates agricultural production, or as low-lying coastal areas confront ocean encroachment. Some of these effects will generate political debate or even social tensions: imagine when middle-class Americans realize that their taxes if not their insurance premiums are subsidizing vacation homes for the wealthy on vulnerable coasts or in increasingly fire-prone mountains. But those situations will not rise to the level of national security. Rather, the security challenges will come in ripple effects arising from the issues operating elsewhere, especially in the globe's poorer countries.

The most obvious of the political and social effects that might pose national security issues are those driven by water scarcity. As suggested earlier, scarcity can lead to either cooperation or competition among affected groups, but it is competition that drives the social effects of most concern. This competition, disruptive enough, occurs between urbanites and displaced rural dwellers moving to cities, as has been seen in many parts of the world, such as South Asia. People moving across national borders to more water-hospitable environments can lead to tensions of many sorts. The migrants may find themselves stuck outside various cordons and fences; there may be recriminations against source countries for not securing their borders and ugly nativist backlashes in destination countries.

Another fault line for competition among domestic groups involves distinct regional entities, such as the Saharan–Maghrebi divide within North African countries. Competition takes place between clans and ethnic groups within a political entity as well. Already weak central governments will be strained by the loss of revenues, new welfare demands, and the upsetting of traditional political balances. Official responses to hard-hit areas are likely to be perceived as inadequate, sometimes stoking preexisting feelings of marginalization and discrimination. Central incapacity and local grievance may prompt insurrection in the underserved hinterlands in areas such as parts of the Middle East. Conversely, autonomy movements in wealthier portions of beleaguered countries could arise, as may already be happening in some Andean

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[1]   In particular, see Chapter 11 of Working Group I's report and Chapter 10 of Working Group II's report.

countries. Poorer states further weakened by climate-induced stress will fare poorly in keeping order.

Moreover, even modest climate-induced sea-level rise—measured in centimeters—expected in the coming decades can make a big difference. Computer modeling shows, for example, that an 18-cm (7-inch) rise in sea level would claim 10 percent or more of the vast freshwater marsh in Florida's Everglades National Park (Kimball, 2007). Saltwater intrusion from rising sea levels is already contaminating underground water sources in Israel; Thailand; small island states in the Pacific Ocean, Indian Ocean, and Caribbean Sea; and in some of the world's most productive river deltas, such as the Yangtze and Mekong (UNFCCC).

Perceptions of impending inundation will probably do more to trigger human actions than actual sea-level rise. In an era of global, accessible communications, reports of scientific results—frequently garbled or out of context—can quickly animate individuals or groups. People may move before they get permanently wet, taking major storms as foreshadowing of the worst. Of the 38 countries in the world with more than a tenth of their populations living less than a meter above sea level, nine are in the Caribbean; thus, contingency planning in Washington will be necessary well before the meter mark is reached (Levy and others, 2008).

China is projected to be a loser, with more people than in any other country forced into a condition of water scarcity, while Russia is projected to have the least threat from that scarcity (Levy and others, 2008). Yet, China's "loss" could spur Beijing in the years ahead to press a claim to secure control of the Amur River and tributaries along the Russian-Chinese border, as well as the rich natural resource base north of the Amur in land once controlled by China.

Alternately, or perhaps in conjunction, a dwindling Russian population in the Far East is creating a perception in Moscow of both a tenuous Russian grasp on the territory and a dynamic "pull" to enterprising or dissatisfied Chinese who might on their own move into an increasingly temperate, habitable, and commercially active Russian Far East. Such a process could come to produce a situation that Moscow would perceive as intolerable, for a Chinese invasion of sorts already looms large in Russian imaginings (Khramchikhin, 2008). At the same time, climate change could provide one more reason for migration from the South Caucasus and Central Asia into Russia, pushing the country's politics in a rightward, xenophobic direction. Both processes—a direct state claim and an undirected immigration flow—could lead to confrontations over borders and migration.

Water Scarcity

Water is truly unique. Certainly there is no other compound that can be substituted for water (Postel and Wolf, 2001). Nor, with the exception of costly desalination, can fresh water be created in quantity. So dealing with scarcity means garnering what is available more completely (through collection and recycling), polluting less, demanding less (through more efficient use), and increasing storage to smooth out natural variations and hedge against shortage. The supply of water is threatened by human activities both general and specific. Climate change is producing changes in temperature and precipitation, potentially producing regional shortages. Humans are also to blame: fast-growing populations, especially in some poorer countries, put increasing stress on supply; economic activities increase per capita water consumption rates and release pollution; and deliberate terrorist activities can threaten supply even in rich countries (Gleick, 1993 and 2006a).

Most water scarcities can be traced to shortcomings in the region concerned, such as poor governance or inadequate infrastructure. However, a nation's water supplies and scarcity can

be—and have been—susceptible to the activities of other nations. For example, Egypt used its international political position to block funding for planned water projects in Ethiopia (Tadros, 1997; BBC News, 2005). During the 1991 Gulf War, Iraq destroyed Kuwait's desalination infrastructure (Gleick, 1993). In Somalia's civil war of the 1990s, rival factions attacked water systems in towns, and stole generators and pipes (Dinar, 2002). It should also be noted that water-related threats to security need not derive solely from water scarcity, though that is the focus here. Too much water can be just as damaging to a nation's people and ability to pursue economic activities. The 2010 floods in northwestern Pakistan are a prime example. Security was threatened from all possible angles. Twenty million people were displaced, many without access to food or water. The flood-ravaged areas were difficult to reach, making them a prime breeding ground for extremists who threaten the security of that region and of the world (Pleitgen, 2010; BBC News, 2010).

The availability of water and implications for security must be considered from a regional standpoint (Dinar, 2002; Gleick, 1993; Seckler, Barker, and Amarasinghe, 1999; United Nations, 2004; Vorosmarty and others, 2010). The supply of water is regional, with many nations sharing a single water source. Indeed, there are more than 250 transboundary lakes and river basins, and 90 percent of the world's population lives in countries that share basins (United Nations, 2008). From the Mesopotamian era to current times, conflicts over water have been defined geographically; water sharing and cooperation treaties have also been regionally based.

So, too, the major security challenges of water scarcity driven by climate change will also be regional. A number of projections imply that within the next decade up to 250 million people in Africa will be subjected to varying degrees of water stress (Intergovernmental Panel on Climate Change, 2007; Seckler, Barker, and Amarasinghe, 1999; Vorosmarty and others, 2010). By 2050, much of the Indian subcontinent, Australia, and New Zealand will face severe water shortages as well. The threat of dwindling water supplies is imminent and real. Parsing the issue of water and security along a regional perspective provides a platform to rank regions according to their overall vulnerability based on climate change, demographic predictions, regional history, current political climate, and the expectation of future cooperation.

By these criteria, the most vulnerable countries will be ones that have been and are politically unstable, which also tend to be poorer and underdeveloped. The manifestations of climate change will differ regionally, though many countries are vulnerable. Some countries in the greater Middle East have always existed in water constrained circumstances, and so will not be much more greatly affected. The more that countries have strong institutions and infrastructure, and are also part of cooperative regions, the better they will be prepared to address climate change and water security, mitigating the impact on their citizens. However, as is the case with countries lacking telephone landlines leapfrogging to cell phones, countries short on infrastructure could, paradoxically, have the opportunity of not having to overcome preconceived notions of how to address these issues or the opposition of those with stakes in legacy systems.

Although water issues are not often considered prominent threats to national security, there is increasing recognition of the cycle that can lead to instability or violence. For example, water scarcity stems from depletion, increased demand, and unequal distribution, and is perhaps exacerbated by global warming. Scarcity can lead to deepened poverty, large-scale migrations, sharpened social cleavages, and weakened institutions. Despite a lack of major interstate "water wars," evidence is accumulating that these chronic problems can result in acute episodes

of conflict, mostly internal but sometimes spilling across borders. For example, the Chiapas, Mexico, conflict in the 1990s was certainly sharpened by scarcity (Chassang and i Miquel, 2008; Homer-Dixon, 2001). One of the roots of the Darfur conflict is the internal migration of pastoralists driven by drought, which upsets the delicate existing allocation between water and pasture (Freire, Lopes, and Nascimiento, 2008; Ng, 2010). The fact that half its urban residents lack reliable access to a water supply is probably both a cause and effect of Yemen's unhappy status as a failed state—and thus a possible base for terrorism (Meleigy, 2010).

While most acute water security issues ensue because social responses to scarcity lead to conflict, the causation can go in the other direction as well: conflict (or narrow national self-interest) can affect water availability, given that 250-plus river basins around the world are shared by two or more countries. When those countries are divided by conflict, water allocations are bound to be seen as unfair, thus exacerbating tension. Obvious examples are India and Pakistan sharing the Indus River, and Israel and Palestine sharing the Jordan River.

In other cases, the increase in tension may arise from narrow self-interest rather than outright hostility. China's dams on the Mekong River, for instance, will only intensify the effects of global warming in reducing downstream flows, perhaps leading to conflict among the downstream countries that are reluctant to confront China directly (Herman and Treverton, 2009). Less obviously, the occupation of the Golan Heights by Israel in 1967 has had lasting significance because it controls a water source that feeds the Jordan River, which is a main contributor of surface water in Israel (Murakami, 1995).

Pandemics

In substance, the case for considering pandemics—that is, the global spread of infectious diseases such as influenza or HIV/AIDS—as a matter of national security is compelling. Pandemics would affect the United States directly, not only indirectly. As Table 2.1 illustrates, of the three issues, only pandemics hold the risk of destroying American society within a foreseeable future. Moreover, one powerful reason for concern about pandemics is explicitly one of security—that terrorists or others might use disease agents as weapons (Heymann, 2003).

Invoking a national security concern can produce a positive spillover in that all the measures designed to improve detection and containment of deliberate or purposeful disease outbreaks before they become pandemics also improve defenses against natural ones. That positive spillover probably extends to many infectious diseases, such as the "routine" flu that each year kills more than 30,000 Americans. However, considering all infectious disease to be matters of national security not only would trivialize the meaning of the term but, more importantly, would provide little guidance about setting priorities.

Yet the question remains of the value, in tactical terms of framing policy, of considering pandemics under a rubric of national security. The arguments about whether to consider HIV/AIDS a security issue provide a foretaste of the larger arguments about pandemics. HIV/AIDS has been visible in the medical community for three decades but only began to be considered as a security issue in the last 10 to 15 years (Prins, 2004). In the instance of HIV/AIDS, practical arguments shaded into ethical ones, especially for the skeptics. On one hand, considering AIDS a national security matter perhaps would have increased international attention and resources directed toward the disease (Elbe, 2006). Yet on the other hand, "securitizing" risks stigmatizes not only the disease, but also those who have it—exactly the opposite intention of efforts to address HIV as any other health problem. It also risks pushing the disease away from

health organizations in civilian society toward military and intelligence organizations. One fear is that those organizations have the power to override the civil liberties of people living with HIV/AIDS (Maclean, 2008).

These arguments against a national security frame should be less powerful for other pandemic diseases. With flu, for instance, the stigma on individuals will be less to the extent that the pandemic is short, and to the extent that those who catch it do not do so through risky behavior. While national responses may entail restricting liberties through quarantines, limits on travel, and the like, those would, in most cases, be a temporary means of containing the spread of disease. Extremely difficult cases would arise if some new virus were, like HIV, to be permanent and lethal for some who caught it but left others who had it seemingly healthy. And imagine, further, if those infected but feeling well could spread it not through specific acts— like unprotected sex or drug injections—but simply in the ways that ordinary flu is spread. In that case, there could be pressure for testing to identify potential carriers, then perhaps for restrictions on how those carriers were allowed to behave, though the disease might move too quickly for that to be practical.

The other concern of those skeptical of "securitizing" HIV/AIDS is that it would bring into play a "threat-defense" logic (Elbe, 2006). That might give pride of place to national responses over international ones, inducing states to shift funding toward their elites and armed forces.[2] It is hard to know quite what to make of this concern. A nation's first responsibility is to its own citizens, so to the extent that national measures are effective, they will have first priority. If these actions restrict the spread of the disease internally, they would likely generate positive spillover benefiting the international community as a whole. That will be especially true if the disease agent in question is relatively easy to transmit. In those circumstances, there is likely to be strong pressure on nations that are perceived as not doing enough to limit the spread from their own citizens.

Commonalities and Connections Across the Issues

All three of the issues are global in scope, though whether water is usefully seen as a challenge to the *global* commons is less clear. Such challenges share, albeit to different degrees, several critical characteristics from a risk perspective. First, they are globalized—or at least "de-localized" in Ulrich Beck's infelicitous language—in that they respect no national borders (Beck, 2006). That is a commonality only in the most conceptual sense, for the manifestations and responses to global issues will arise—in varying degrees—regionally. So even though climate change is global, responses will be national or regional.

Second, they have a social component in the sense that individuals, acting in their own interest, can generate negative effects on the commons. That is true whether people release carbon into the atmosphere, increase water demand in an area by migration, or simply enjoy the benefits of rapid travel by air. In that sense, if they can be regarded as global threats, they are "threats without threateners." That is, the despoilers of the commons mean no harm; they only seek benefits for themselves (Treverton, 2009). Figure 2.1 displays that point. Organized crime is somewhere between a purposeful threat and a threat without threateners because the

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[2] In one sense, AIDS was "securitized" very early in classified U.S. government reporting on its prevalence in foreign militaries.

Figure 2.1
Range of Purposeful Threats and "Threats Without Threateners"

Range of intent

Purposeful threats

"Threats without threateners"

Increasing risk of lethality

Organized crime

Drug traffickers

Terrorists

Climate change
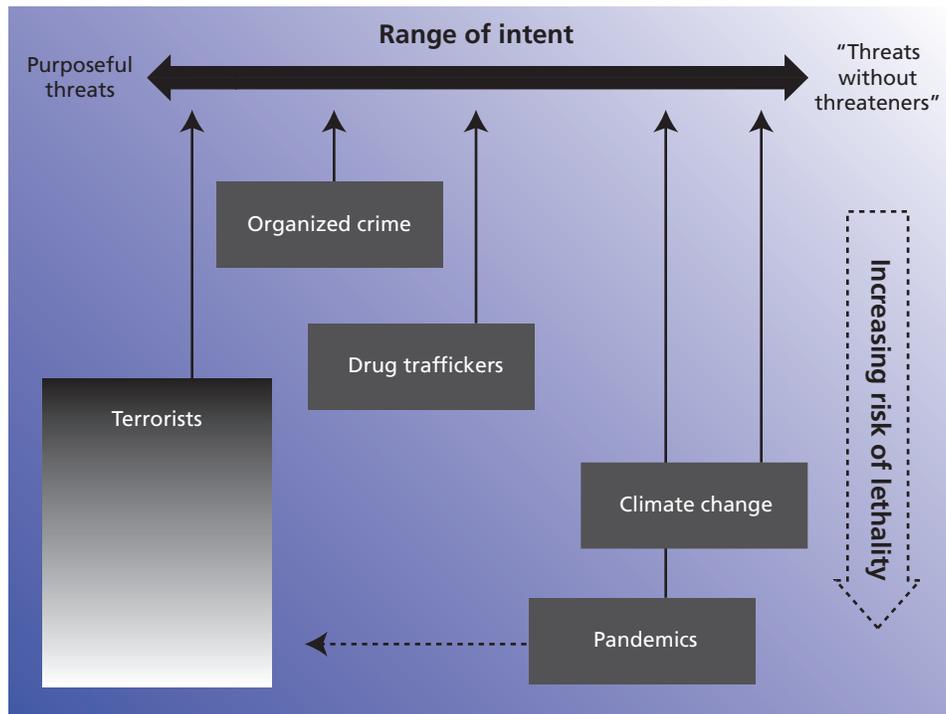
Pandemics

violence and lawlessness it generates can endanger security even though the main purpose of the criminals is only to enrich themselves, not harm innocents. For pandemics, the dotted lines indicate where a threat without a threatener might be revealed to be a purposeful threat (e.g., from a terrorist group)

The third common characteristic is the temporal perception of risk. Climate change and global water scarcity are chronic problems, with effects building slowly over time, perhaps coming to a tipping point unpredictably. Inaction today may carry little cost. Their risk is thus very hard to calculate. Global warming seems a certainty and its impact may already be felt, but for the most part the timing and magnitude of its consequences are future and uncertain. Pandemics are similar. While some new virus is a virtual certainty—after all, the flu season happens every year—exactly when a new disease with pandemic potential might strike is uncertain, and so is its lethality: will it be devastating or, like H1N1, relatively low in lethality? In that sense, very lethal pandemics are low probability–high consequence events—ones that people find very difficult to calibrate and address in advance.

For example, a generation ago, researchers compared the assessments of experts with those of nonspecialist citizens on a low probability–high consequence risk, that of nuclear power. Two groups of citizens ranked the risk posed by nuclear power as first in a list of 30 activities and technologies, and the third group ranked it eighth. By contrast, experts ranked it twentieth (Slovic, 1987). For nuclear weapons and nuclear war, the gap was even wider. On issues like nuclear power where evidence is available, the experts' views did tend to correlate with that evidence, like numbers of fatalities. Happily, there was no data on nuclear war.

Moreover, all three problems are, in varying degrees, chronic, not acute. To be sure, when pandemics hit, they will be acute, as will short-term, local or regional water shortages. Yet beforehand, gradual emergence of a threat makes it all the harder to raise public awareness and garner cooperation on solutions. That is particularly the case for climate change. Perhaps fundamental biological factors compound the challenge. Human beings, with their adrenal glands, are best at dealing with acute threats ("fight" or "flight"), not chronic ones. More- over, sensory organs of the nervous system adjust to ambient conditions, and, as a result, slow change is difficult, if not impossible, for humans to appreciate.[3] Also, human senses that may have been adequate for detecting naturally occurring threats at some point are less effective at detecting man-made threats without the aid of sensors—carbon monoxide alarms are a good example.

These perceptual factors, combined with the difficulty of estimating effects and hence risks, makes it hard to rally support for action. Pandemics are only slightly different: witness the fact that less than half of adult Americans prepare for the annual flu season by getting vaccinated (Harris and others, 2011). The risk of all three issues may increase over time as glo- balization continues to bridge physical distances, and there is also deep uncertainty associated with them. Thus, reaching agreement on how to prepare now for uncertain future threats will also be difficult. All three require current investments for future and perhaps highly uncertain gains. The humankind-threatening pandemic may hit, but if and when are deeply uncertain.

To the extent that they are commons problems, the three issues are beset by "free riding." Free riding is most visible for climate change in that all nations would like to reduce global carbon emissions but many would prefer that other nations undertake the reductions. They would prefer to have *both* the global benefits of the reduction and the national benefits of main- taining or even increasing current emissions. Because all nations face the same incentive, in the absence of some form of cooperation or coercion, none has an incentive to cut emissions and all will suffer the effects of climate change. They will all be tempted to be free riders.

Metaphorically, this is the classic multi-agent prisoner's dilemma. It is the extension from the two-person prisoner's dilemma to many players. In the classic example, the police arrest two suspects but lack enough evidence for a conviction. The two are kept separate and offered the same deal. If one testifies for the prosecution against the other (*defects*) and the other remains silent (*cooperates*), the defector goes free and the silent accomplice receives the full ten- year sentence. If both remain silent, both prisoners will be sentenced to only six months in jail for a minor charge. If each betrays the other, each receives a five-year sentence. Absent coopera- tion, the rational choice is for both to defect, and even with cooperation the incentive to defect will remain, and be all the stronger the more one expects the other to cooperate.[4]

In all three cases, there is no global authority to regulate behavior to avoid despoiling the commons—in short, no form of deviation-resistant cooperation to escape the prisoner's dilemma of free-riding. WHO International Health Regulations are a partial exception, for

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[3] As a specific example, the retina of the human eye maximizes the ability to detect spatial contrast by adjusting sensitiv- ity to the ambient level of illumination. The adjustment trades the ability to track absolute change for precision in relative assessments of brightness (see Kandel, Schwartz, and Jessell, 1991, p. 408).

[4] This logic is meant as metaphor, not formal theory, and it is most powerful in single-play "games." More theoretically, in a repeated game that the players know they will be playing for a while without a certain end point, there are what are called "Nash equilibriums" that do not involve dual defection. Tit-for-tat strategy can lead to one such equilibrium if one agent first cooperates, then responds in kind to what the other did previously.

Table 2.2
Commonalities Across the Three Issues

Issue	Global, or at Least Nonlocal	Result from the Sum of Individual Decisions	Chronic or Acute	Free-Riding a Problem	Lack of International Institutions to Regulate
Climate change	Yes, fully global	Yes, a threat without threatener	Chronic	Yes	Yes, although UNFCCC is a weak beginning
Pandemics	Yes, fully global	Yes, but could be deliberate	Can be both (chronic in prospect, outbreaks acute)	Limited to hiding scope	Yes, although WHO provides standards
Water scarcity	International, not yet global	Yes, but water can be used as a weapon	Either	Temptations to cheat on international agreements	Yes, although treaties allocate common good

they have the force of treaty or law, and reflect at least the shared willingness to accept some common standards. The 1987 Montreal Protocol, seeking to reduce the release of chlorofluorocarbons (CFCs) and other gases that deplete the ozone layer, and the 1997 Kyoto Protocol, addressing climate change, represent the modest beginnings of some international framework. The fate of legislation in the U.S. Congress in recent years to reduce GHG emissions clearly illustrates the problem of collective action.[5] Even a scaled-down proposal, only covering utilities, faced an untimely legislative end. Table 2.2 summarizes the commonalities across the three issues.

The connection between climate change, or global warming, and water scarcity is clear, and it may already be visible. Climate change and water scarcity might facilitate pandemics, both natural and purposeful. On the natural "threat without threatener" side, climate change might have an impact on the patterns of diseases. On the purposeful threat side, a reduction in water availability might make remaining supplies more attractive targets for deliberate contamination. Climate change and water scarcity are both related to the production of energy. Moving toward cleaner energy sources would mean less air pollution but also less water contamination, though drilling for natural gas can pollute ground water. In general, avoiding water contamination becomes increasingly important as water scarcity intensifies.

Migration makes critical connections among the three. The connection is strongest with water scarcity, where migration driven by the search for water already has been a source of conflict, when areas to which the water-hungry migrate are unprepared or unwilling to accept them. Climate change will touch off migration both as water becomes locally scarce, when sea levels rise, or the climate becomes uninhabitable due to extreme heat or cold. Disease, too, might touch off movements of people, and such movements, however caused, might also touch off disease, exporting diseases to places that did not have them. That is the fate that befell native populations in the Americas when European colonizers arrived.

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[5]   Cap and trade, also known as emissions trading, was the best known of these initiatives. It is a market-based approach to reducing harmful emissions. The cap or limit is allocated or sold to firms by a government authority. Firms can buy or sell—trade—permits, and so those firms that can reduce emissions most cheaply will do so, achieving the reduction in emissions at the lowest cost to society.

Differences Among the Issues

There are also differences among these issues, ones that matter in framing policy approaches. One is the timing of their connection to the global commons. As soon as it became identified as an issue, climate change was associated with the global commons. Certainly the *effects* of climate change will be differential across the globe; there will be winners and losers. But with respect to despoiling the commons, the *origin* of the carbon dioxide emission is irrelevant, though of course the origin matters when it comes to policy approaches. By contrast, although the 1918 flu epidemic offered an agonizing preview, not until the arrival of mass travel by jet did pandemics seem usefully perceived as a global commons issue.

Water is different still. Water issues always have been commons issues at levels from local to international: witness dividing river waters, from the Colorado River in the U.S. Southwest to the Nile River in Africa. Today water is becoming a global *business*, as water-rich areas sell it to areas in need, raising questions about who "owns" water and who should protect water sources—the source or recipient country. International treaties covering river basins typically *divide* a common resource to share it as a public good, not seek to prevent it from being despoiled. Typical features of such treaties are described in the Indus River basin case in the next chapter. The agreements usually have some means of trying to make quotas visible if not really enforceable. The free-rider problem emerges, at least in a metaphorical sense, to the extent that national signatories are tempted to cheat or waste water in ill-considered projects.

Time is important in a second respect: the immediacy of effects is directly related to the difficulty of assembling a collective response. Climate change is the classic case of a chronic, not acute, threat. The cost of inaction today is borne only much later. To be sure, while climate change is long term and global, its causes can be acute and regional. For instance, smog has serious immediate health consequences. As a result, visible and man-made (anthropogenic) causes of climate change may help build support for addressing the issue.

The rub is human sensory perception: we may live in smog but not really see it unless we drive into the hills and look down. Worse from a coalition-building standpoint, events in the present can be taken to lessen the need for action: witness a frigid winter in America's Northeast in the face of global "warming" alarms, not to mention Pakistan's 2010 flood which belied its long-term problem of water shortage. For pandemics, the effect of a disease will be visible soon, though perhaps not soon enough to stop the spread. For water, the effects can range in time from immediate scarcity to permanent changes in supply that reduce crop yields and change migration patterns.

A third difference is links to malevolent foes. Here, climate change stands out. For the foreseeable future, it does not seem possible for foes to inflict climate change on their enemies. However, as the need for geoengineering responses to global warming becomes more apparent, nations will differ in how they view particular measures, and there will be particular debate over the spillover effects on nations from another country's geoengineering activities (Lempert and Prosnitz, 2011). In contrast, pandemics could result either from a foe's action or from the "normal" processes of Mother Nature in an era of ubiquitous airplane travel. Critically, it might not be easy to identify which of the two was the cause of the pandemic. In the immediate aftermath, that would not matter much, for the public health response (quarantine, triage, and the like) would be similar whether the pandemic was natural or man-made.

Water again seems to be in the middle of the spectrum. Locally, water scarcity may result in conflict, and conflict—or narrow self-interest—may also lead to water scarcity. Water scar-

Table 2.3
Differences Across the Three Issues

Issue	Acute or Chronic Threat	Timing of Association with Global Commons	Deliberate or Nondeliberate	Regional or Global	Viability of Unilateral U.S. Action
Climate change	Chronic	Immediate	Nondeliberate	Global but regional effects	Limited effectiveness of unilateral
Pandemics	Chronic, though outbreaks acute	Delayed until era of jet travel	Either; problem of attribution critical	Least regional	Effective, with added benefit from multilateral
Water	Acute or chronic	Delayed, immediate with local commons	Either	Most regional	Necessarily multilateral

city can be caused by deliberate contaminations to supply or systems can be destroyed deliberately during times of conflict. That was the case, for instance, with the intentional destruction of desalination capacity and the water supply and sanitation systems in Kuwait and Iraq in 1991, as well as the deliberate contamination of wells in Darfur in 2004 (Gleick, 2006b).

A fourth difference is how regional the manifestations of these issues are, even if all can be characterized as global. Pandemics are the least regional of the three, for because of far-reaching airplane travel, pandemics can spread quickly across the world from the origin.[6] Water is the most regional. While the image of a global water commons is vivid, the manifestations of scarcity (however caused) will be regional, though for major tributaries like the Nile or Hindus, the region may be quite large. Climate change may be somewhat in the middle. The first-order effects of climate change will be regional, as people in low-lying areas migrate or water scarcity exacerbates conflict. So, too, the effects of geoengineering approaches will probably be mostly regional, but, again, the regions could be quite large depending on the approach.

A fifth difference from the perspective of U.S. national security may be how amenable the three issues are to unilateral U.S. approaches. The most threatening of the three to security, pandemics, is also the one most amenable to national action. The United States could undertake many unilateral actions (quarantines, improved public health capabilities, monitoring systems for early warning of outbreaks) to improve its ability to weather a pandemic. These measures would be even more effective if pursued jointly with other countries, but the United States could gain significant advantages by simply implementing them domestically. The risks posed by global warming, on the other hand, are more resistant to unilateral actions, and many of the risks posed by water scarcity turn on the behavior of other countries, like China and India, so there are no U.S.-only solutions to those challenges. Table 2.3 summarizes these differences.

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[6] This is exactly why H1N1 was classified as a pandemic—the entire world was affected simultaneously, according to a recent Security and Defence Agenda (SDA) report (Dowdall, 2011).

Conceiving Policy: Suggestive Cases

In reviewing previous approaches to tackling these challenges, and in framing new ones, there are two points of departure. One is the challenge to governance of the commons problem that all three issues share to some extent—current sacrifice for future and uncertain gain. At the national level, the problem of free-riding requires some level of government coercion: no matter how popular national defense is in the United States, no one thinks it could be funded by voluntary donations. Reaching agreement on policy issues beset by some form of free-riding has often required special mechanisms for political commitment a priori. Examples include the congressional precommitment to trade agreements and the Base Realignment and Closure Commission, which sought precommitment to the results of an expert panel making recommendations for closing or amalgamating military bases. However, a priori commitments are rare even at the national level. They are virtually absent internationally.[1]

The second point of departure is the utility of bringing a security perspective to bear. Arguably, efforts to reduce GHG emissions have not progressed much in the United States because global warming has been treated primarily as a scientific issue, which led to a regulatory approach ("do with less"), not a national security one. Some measures to reduce emissions also would reduce dependence on foreign oil, which could have reframed it as a security matter, as some have suggested. However, the reframing was interrupted first by high oil prices and then by the economic crisis.

For all the attention to the danger of pandemics—it is hard to imagine another threat to the very existence of nations, including the United States, justifying their top threat ranking in Table 2.1—there has been much less attention to their security implications (Garrett, 1995). This is true despite the fact that, if a pandemic struck, it would not be immediately obvious whether it was a purposeful terror attack or the natural result of a changing disease environment. In retrospect, the threat of the H1N1 virus seems exaggerated, but the world was simply lucky that the actual virus caused fewer deaths than expected.[2] In that sense, the H1N1 episode was a good test of national and international preparedness.

Thus, in principle all three issues can usefully be characterized as having national security implications—even if from the perspective of the United States most of those are indirect, not direct. That is perhaps clearest with regard to water scarcity, which is most likely to lead to

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[1] This fact makes NATO's Article 5 commitments all the more unique. In it, the parties pledge that "an armed attack against one or more of them in Europe or North America shall be considered an attack against them all." It has been invoked only once—on September 12, 2001 in support of the United States.

[2] In recent discussions on pandemics hosted by the Security and Defence Agenda there was strong consensus that H1N1 was mild, but the threat was very real, and so provided countries the opportunity to 'test' their preparedness systems (Dowdall, 2011).

migration and conflict in poor countries. Such conflict will spread in concentric circles, leading to conflict and instability in neighbors. For the country concerned and those neighbors, the security issues will be direct. For the United States, they will be indirect, ranging from human disaster, to instability in strategically located countries, to the risk of havens for terrorism.

Yet the tactical issue of framing the issues as ones of "security" remains. On one hand, invoking "security" in relation to an issue is usually tantamount to calling it "important." And security, when deemed "national," usually connotes some sense of sacrifice for the common good. On the other hand, practitioners in some fields dislike the security label. Those in the economic development business, for instance, fear that invoking security will be an argument for giving money to rich security partners, like Israel, rather than truly needy countries. And many in the health field may regard themselves as in the human security business but not necessarily the national security business.

The cases that follow illustrate different policy approaches to come to grips with big global problems, like threats to the commons. The cases have been chosen for illustrative purposes. They suggest lessons about what has worked and what has not. They span the globe and represent a sample of security-related commons issues. The Indus River case is illustrative of the usual policy approach to shared river resources: formal negotiations among the basin states, often with some international mediation and financial incentives. The other water case, drought in Ethiopia and implications for the Horn, illustrates the challenge to finding solutions when water scarcity or events create new migration patterns. The Montreal and Kyoto Protocols are two examples of formal international negotiations that deal with climate issues. The outbreak of severe acute respiratory syndrome (SARS) shows the international community dealing with a major emerging disease as a kind of coalition of the willing, with WHO playing a role as coordinator.

Indus Waters Treaty

Irrigation systems have been present along the Indus River for centuries. Irrigation systems in the Indus basin (shown in Figure 3.1) were extensively developed during British rule in the Indian subcontinent.[3] Issues that arose over water resources could be swiftly resolved by British authorities. For instance, when the 1935 Government of India Act granted greater autonomy to the provinces of India, disputes over water projects arose, especially between Punjab and Sind (Wolf and Newton, 2008). In 1942, Britain organized a commission to examine the disputes over development plans between Punjab and Sind. The commission recommended an integrated management plan for the Indus River basin. Punjab and Sind opposed the commission's recommendations. Technical experts from both sides participated in negotiations and the matter was sent to Britain for final resolution.

However, before a decision could be rendered, India declared independence and the dispute became international between the newly independent India and Pakistan. Transboundary water resource issues in the Indus basin were not adequately planned for in the partition. Joint control and management of water resources were envisioned, but no tangible steps were taken toward their implementation. Engineers from India and Pakistan negotiated a Standstill Agreement, which maintained water allocations to Pakistan. In 1948, immediately upon

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[3]   David Howell was the original author of this case.

Figure 3.1
Indus River Basin
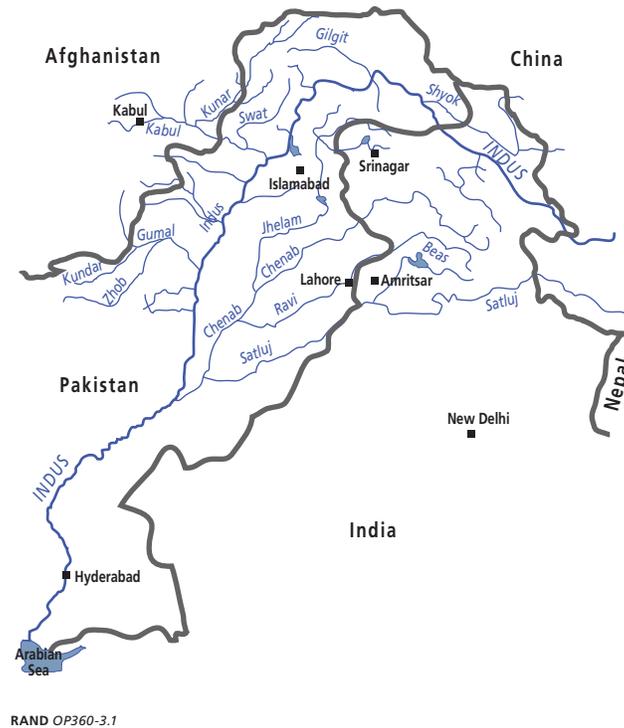
expiration of the Standstill Agreement, India stopped the flow of Indus waters to Pakistan at key locations. Flows were reestablished less than a month later, but the incident highlighted Pakistan's vulnerability to India's control of the Indus waters (Wolf and Newton, 2008).

India maintained that Pakistan recognized India's rights to the waters by agreeing to make payments for water delivery under the Standstill Agreement. While a longer term resolution was sought, the two sides signed the Delhi Agreement, which assured Pakistan adequate water or at least enough time to complete projects for new sources of water before supplies ceased. After signing it, Pakistan almost immediately issued an official complaint against the Delhi Agreement, calling instead for third party administration of equitable water resource allocations.

The World Bank pursued a resolution of the dispute with the eventual goal of joint management of the Indus River basin. While some data was shared, India and Pakistan remained unable to come to an agreeable division of Indus water resources. The World Bank ultimately abandoned joint management goals for the basin. Instead, the Bank proposed that India be allocated the entire flow of the eastern rivers and Pakistan the entire flow of the western rivers. India would be allowed some use of the western rivers; however, such use would be tightly controlled by the terms of the treaty so as not to hinder flow to Pakistan (Article III). One crucial aspect of the proposal was allowing a transition period so that Pakistan could complete development projects to facilitate alternate water sources.

The arrangement was hardly ideal but was probably the best that could have been achieved given political tensions between the two (Alam, 2002). Further negotiations focused

on determining whether particular development projects would be identified as "replacement" or "development." India would be financially responsible for replacement facilities, but not for development facilities. Recognizing that resolution of such disputes on a project-by-project basis could be a serious roadblock, World Bank representatives shifted focus from assessing financial responsibility for specific projects to determining a total financial responsibility for India (Sridhar, 2005). India agreed to financial responsibilities of $174 million and the international community raised almost $900 million.

In 1960, the Indus Waters Treaty was signed by both parties and subsequently ratified. The treaty provided a ten-year transition period whereby Pakistan was able to continue using prior water sources until development of new sources was completed. After the transition period, the allocations established by the treaty would take full effect. In addition, the treaty created the Permanent Indus Commission, which is responsible for the implementation of the treaty and resolution of issues (Jain, Agarwal, and Singh, 2007). The commission is composed of one commissioner from each country. If a difference cannot be resolved between the two commissioners, a neutral expert is appointed to decide the matter. The neutral expert is to be a highly qualified engineer chosen jointly by the two governments (Miner and others, 2009). Alternatively, if one month passes from the time of the initial request without an appointment, the World Bank may appoint a neutral expert after consulting with both parties. If the neutral expert cannot come to a decision, it is considered a dispute and both governments can dispatch negotiators to try to resolve the dispute. If a resolution is still not reached, the dispute is considered by a Court of Arbitration. The Court of Arbitration is composed of seven members—two appointed by each party, a chairperson, an engineer, and an international law expert (Thatte, 2008).

Net Assessment

The Indus case displays a number of features typical of initiatives to share riparian resources. The role of the World Bank as mediator was important, as were financial incentives. When progress stalled over which nation would pay for particular projects, the way around was to settle on bottom-line financial compensation that India and the international community would provide to Pakistan. Pakistan was then able to pursue projects as it saw fit, while India had a predetermined financial commitment. More generally, the prospect of new development projects can be a powerful incentive to agree.

Agreement on a transition period let Pakistan pursue many replacement facilities to exploit new sources of water. The arrangements supported Pakistan's water needs during this transition until new capabilities could be realized. Temporary agreements, like the Standstill Agreement, may be facilitated if they explicitly state that the actions do not represent a new precedent. Negotiations tended to make more progress when they centered on new approaches to meet water needs rather than arguing claims based on historic rights to water resources.

Drought in Ethiopia, Conflict in the Horn of Africa

The region known as the Horn of Africa—composed of Djibouti, Eritrea, Ethiopia, Kenya and Somalia—has endured continual and intense hardship for decades, as a result of water shortages. Droughts have resulted in famine, hundreds of thousands of displaced persons, and armed conflict, which are all issues even today (Ofcansky and Berry, 1991). From 1969–1990,

Ethiopia experienced at least three multiyear droughts (1969, 1978, 1987) touching off three severe famines (Ofcansky and Berry, 1991). Over this time period, hundreds of thousands of people died and at least 3.5 million were displaced into Somalia, Sudan, Djibouti, and Kenya (Ofcansky and Berry, 1991).

Then, in the 1990s, returning Ethiopian refugees, in particular those from Somalia, either resettled in or caused other groups to move to areas still plagued by drought (IRIN News, 2000). This has resulted in continual clashes within Ethiopia and along its borders for more than a decade. Pastoralists have been both the instigators and victims of this conflict becaues their livelihood depends on water. Conflict can result when they migrate to find it (Cultural Survival, 2002). In 2000, the desire to control key watering and grazing points in anticipation of future rains was the source of conflict between the Borena and the Garre communities, which spilled into Kenya as well (IRIN News, 2000). Note that this is consistent with the Chassang and i Miquel model (2008). Current droughts reduce the opportunity cost of fighting now because that fighting doesn't much reduce future gains. In 2002, there were multiple clashes between Ethiopian and Djibouti pastoral tribes (Cultural Survival, 2002; IRIN News, 2002). The consequences of a particular instance extended to other realms of the economy: fearful truck drivers refused to travel through the area, resulting in fuel shortages in Addis Ababa, hundreds of miles from the conflict zone; additional conflict was sparked later in the year between the same groups (Cultural Survival, 2002). Water shortages have also resulted in clashes between members of the same ethnic group. For instance, fighting over wells and pastoral lands broke out within the Hawiye clan along the Ethiopian-Somali border in 2004 (BBC News, 2004).

The same story was repeated throughout the region for the rest of the decade, exacerbated by yet another severe drought in 2004 (Wax, 2006). Clashes occurred in Somalia in 2005; there was intraclan conflict in Ethiopia in 2006; and conflict arose along the Kenyan-Ethiopian border in 2006 (AP, 2005; BBC News, 2006; Reuters, 2006). Recently, there have been changes in the types and severity of the conflict. In 2009, clashes between the Borena and the Garre in Ethiopia reached a new level, when an attack came at night over who would control a government borehole (BBC News, 2009).

Net Assessment

Water shortages have caused spillovers into spheres traditionally not associated with pastoral life. One of the clashes resulted in fuel shortages elsewhere in the country. The severe drought of 2004 caused negative health externalities as well. As people in Ethiopia migrated to find water, they spread measles and meningitis, bringing a new threat of disease to destination locales (IRIN News, 2006). The violence has been sustained over time and throughout the region due to a negative feedback loop. Pastoralists need weapons to protect the livestock (Mekonnen, 2006). As water scarcity increases, these weapons are used against other tribes, or even their own tribesmen, to protect scarce water sources or stake claims on future ones.

Governments have not taken measures such as large-scale irrigation projects because many governments are ineffectual or too poor, further exacerbating the security issues (Mekonnen, 2006; Wax, 2006). For example, Somalia did not have a government for many years. When a fledgling cabinet was finally founded in 2004, it was housed in Kenya because Somalia was too unsafe (AP, 2005; BBC News, 2004; Wax, 2006). Because of the intense and continued clashes, governments are forced to spend scarce resources on security forces to protect borders and prevent conflict, thus further contributing to a lack of viable, long-term solutions

(Mekonnen, 2006; Reuters, 2006).[4] If governments wait to send armed personnel, they run the risk of provoking rebellion and further violence among people who want to see the government take proactive measures (Mekonnen, 2006). It is clear that a very different policy approach is required to break this downward spiral.

Montreal Protocol

Former UN Secretary General Kofi Annan said of the Montreal Protocol that it is "perhaps the single most successful international agreement to date."[5] Scientists had been concerned about ozone depleting chemicals (ODCs) since the early 1970s, and in 1985 the Antarctic ozone hole was first identified. That same year, the Vienna Convention established mechanisms for international cooperation in research into the ozone layer and the effects of ODCs. On that basis, the Montreal Protocol on Substances that Deplete the Ozone Layer was negotiated and signed by 24 countries and by the European Economic Community in September 1987. The protocol called for the parties to phase out the production and use of ODCs, especially chlorofluorocarbons (CFCs), by 2000.

Montreal also provided that the use of the interim replacement for CFCs, hydrochlorofluorocarbons or HCFCs, will be frozen in 2013 and begin to be phased out in 2015. HCFCs, themselves less ozone depleting than CFCs, will be replaced by still less ozone depleting hydrofluorocarbons, or HFCs. Although the major chemical companies resisted action, their resistance was tempered, first, by the breadth of the agreement, which meant competitors would be similarly constrained, and, second and most important, by the availability of substitutes.

The other innovation of the Montreal Protocol is the multilateral fund to help poorer countries phase out ODCs. The fund reflects the principle that all nations share a stake in preventing this particular abuse of the global commons but have different abilities to contribute. It is managed by an executive committee with an equal representation of richer and poorer countries. For parties that contribute, up to a fifth of their contribution can be in the form of their own relevant projects and activities. Pledges amounted to US$2.1 billion over the period 1991 to 2005 and were used to finance the conversion of existing manufacturing processes, train personnel, pay royalties and patent rights on new technologies, and establish national ozone offices.

Most importantly, this protocol has worked. It has phased out nearly 97 percent of the 100 ODCs. A 2006 scientific evaluation of the effects of the protocol states, "The Montreal Protocol is working: There is clear evidence of a decrease in the atmospheric burden of ozone-depleting substances and some early signs of stratospheric ozone recovery" (National Oceanic and Atmospheric Administration, 2006).

The protocol has also had the side effect of reducing GHGs. It has eliminated the equivalent of more than 200 billion metric tons of such gases, or five years' worth of total global emissions (Broder, 2010). That is far more than the Kyoto process. With Kyoto and domestic climate change legislation in the United States stalled, attention is turning toward ending the use of HFCs through the Montreal Protocol. The Obama administration has backed the

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[4]   This is especially true during prolonged periods of drought, as traditional methods of conflict resolution conducted by tribal elders become ineffectual (Mekonnen, 2006).

[5]   This statement is so widely quoted that it is difficult to trace its provenance. See, for instance, http://www.epa.gov/ozone/awards/ (as of December 6, 2011).

idea, and no congressional or industry opposition has surfaced. Would-be opponents pose the legalistic argument that since HFCs have little impact on the ozone layer, they should not be handled through the Montreal process.

Net Assessment

The policy probably deserves the praise Annan gave it. It did, though, benefit from a number of contextual advantages. The main businesses affected were relatively few, the target was specific, and there were available substitutes at hand. The fund can be conceived of as a relatively low-cost way to buy off potential free riders. For all those reasons, it was a case in which a traditional approach to commons problems—international negotiations, primarily among states—could be successful.

Kyoto Protocol

If Montreal is a "how to" case of international negotiations dealing with a global commons problem, Kyoto seems a "how not to" example. However, the circumstances of the two negotiations were very different. The Kyoto Protocol is a set of rules under the United National Framework Convention on Climate Change (UNFCCC or sometimes FCCC) aimed at fighting global warming. The UNFCCC is an international treaty whose goal is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (Article 2).[6]

This protocol was initially adopted on December 11, 1997, in Kyoto, Japan, and entered into force in February 2005. As of November 2009, 187 countries had signed and ratified the protocol, *not* including the United States. Under the Kyoto Protocol, all countries give general commitments, while 39 industrialized countries and the European Union (called "Annex I countries") commit themselves to reduce their production of four GHGs and two other gases, including HFCs by 5.2 percent from the 1991 level. The benchmark levels for reduction were the values of "global warming potential" calculated for the Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (IPCC, 1995). The process essentially converted the various GHG emissions into comparable CO_2 equivalents.

Kyoto allows for a number of what it calls "flexible mechanisms" to allow the Annex I countries to meet their GHG targets: emissions trade, clean development mechanisms, and joint implementation. In practice, these mean purchasing GHG emission reductions credits from elsewhere, doing financial exchanges, or accomplishing projects that reduce emissions in non-Annex I countries, in other Annex I countries, or in Annex I countries with excess allowances. Each Annex I country is required to submit an annual report of inventories of all anthropogenic GHG emissions. These countries nominate a person (called a "designated national authority") to create and manage their GHG inventories. Virtually all of the non-Annex I countries have also established a designated national authority to manage their Kyoto obligations, specifically the clean development mechanism process deciding which GHG projects they wish to propose for accreditation by the Clean Development Mechanisms (CDM) Executive Board.

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[6] The full text of the convention is available at http://unfccc.int/essential_background/convention/background/items/1353.php

Kyoto aimed for a legally binding international agreement, with all participating nations committing themselves to an average reduction in GHG emissions of 5.2 percent from 1990 levels by the year 2012, when the protocol expires. According to the treaty, Annex I countries are to have fulfilled their obligations of reduction of GHGs by then. The protocol establishes five principles:

1. Commitments, the protocol's heart, that are legally binding for Annex I countries
2. Implementation, through national measures but also including joint implementation, clean development mechanisms, and emissions trading in order to be rewarded with credits that would allow more GHG emissions at home
3. Minimizing impacts on poorer countries by establishing an adaptation fund for climate change
4. Accounting, through regular reporting and review
5. Compliance through a Compliance Committee.

The main criticism of Kyoto is simply that it has not accomplished much of anything. The lack of specific commitments from developing countries—especially China, the world's largest emitter of GHGs—provided a convenient argument for the United States (and initially Australia) to opt out. There was a certain fairness in the arguments of the developing countries, which said that the rich countries, in effect, got rich by burning hydrocarbons but were now trying to deny poorer countries the same path to riches.

In the Montreal Protocol, a related argument was overcome by the relatively inexpensive multilateral fund to help poorer countries. A more elegant argument was also put forth about "climate justice" (Liverman, 2009) asserting that the developing countries should not have to pay twice because they are both low emitters by comparison to the rich countries—on a per capita basis, China emits less than a fourth what the United States does—and the most vulnerable to the effects of climate change.

However plausible are the arguments for essentially licensing the developing countries to free ride, they did not carry much weight in U.S. politics. When the United States opted out, that meant that seven of the top ten emitters passed on the protocol. Not surprisingly, then, Kyoto did not have much effect. According to the World Bank, by 2005, energy-related emissions had grown 24 percent from 1997 levels, when Kyoto was negotiated. The Bank also found that the treaty had provided only limited financial support to developing countries to assist them in reducing their emissions and adapting to climate change (World Bank, 2010).

Net Assessment

Kyoto was either small and late, or early and ambitious. Perhaps it was both. It was small and late in the sense that by the time it was adopted there was so much inertia in the system that, even if it had met its targets, global warming would continue. Indeed, many of those concerned about climate change refrained from talking about the task of coping with the implications of global warming lest doing so divert attention from mitigation efforts like Kyoto.[7]

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[7] Like any group of specialists, those on climate change have their own vocabulary, which sometimes departs from common English. For climate change, mitigation does not mean what it would in ordinary speech—acting to ameliorate the negative effects of climate change. Rather, mitigation means reducing GHG emissions. Coping with change is called "adaptation."

It was early and ambitious in the sense that the targets for rich countries were reasonably demanding and the poor countries were given a pass. As China became the globe's largest contributor to warming, that omission gave U.S. politicians an easy out: we'll participate when they do. In contrast to Montreal, small side payments to the potential free riders would not suffice. For China and the others, the argument was one of principle: "if you did it, so can we." Additionally, GHG contributors are diffuse, not just a few main companies, and there are not clearly available substitutes at hand to fully meet energy needs.

Severe Acute Respiratory Syndrome

SARS is a viral disease in humans. In the near-pandemic that occurred between November 2002 and July 2003, there were 8,096 known infected cases and 774 confirmed human deaths (World Health Organization, 2003). This resulted in an overall case-fatality rate of 9.6 percent, which leapt to 50 percent for those over age 65. By comparison, the case-fatality rate for influenza is usually less than 1 percent and primarily among the elderly, but can rise as high as 33 percent in locally severe epidemics of new strains. The 2009 H1N1 virus, which killed about 18,000 people worldwide, had a case-fatality rate of only 0.01–0.03 percent.

SARS spread from Guangdong province in southern China, and within a matter of weeks in 2002 and early 2003 had reached 37 countries around the world. On April 16, 2003, WHO issued a press release stating that a coronavirus identified by a number of laboratories was the official cause of SARS; the virus probably had originated with bats and spread to humans either directly or through animals held in Chinese markets. WHO set up a network dealing with SARS which consisted of a secure website to study chest X-rays and to conduct teleconferences.

The first clue of the outbreak seems to have appeard November 27, 2002, when a Canadian health intelligence network, part of the WHO Global Outbreak and Alert Response Network (GOARN), picked up reports of a "flu outbreak" in China through Internet media monitoring and analysis and sent them to WHO. WHO requested information from Chinese authorities on December 5 and 11. WHO issued a global alert on March 12, followed by one from the U.S. Centers for Disease Control and Prevention.

Singapore and Hong Kong closed schools, and a number of countries instituted quarantine to control the disease. More than 1,200 were under quarantine in Hong Kong, while in Singapore and Taiwan, 977 and 1,147 were quarantined respectively. Canada also put thousands of people under quarantine. In late March, WHO recommended screening airline passengers for SARS symptoms. Singapore took perhaps the most extreme measures, first designating a single hospital for all confirmed and probable cases of the disease, then requiring hospital staff members to submit temperature checks twice a day. Visiting at the hospital was restricted, and a phone line was dedicated to report SARS cases. In late March, Singapore invoked its Infectious Diseases Act, allowing for a ten-day mandatory home quarantine to be imposed on all who might have come in contact with SARS patients. Discharged SARS patients were under 21 days of home quarantine, with telephone surveillance requiring them to answer the phone when randomly called.

Despite the alerts, it was not until early April that SARS began to receive much greater prominence in the official media, perhaps as the result of the death of an American who had apparently contracted the disease in China back in February, began showing symptoms on a flight to Singapore, and died when the plane diverted to Hanoi. In April, however, accusations

emerged that China had undercounted cases in Beijing military hospitals, and, under intense pressure, China allowed international officials to investigate the situation there, which revealed the problems of an outdated healthcare system, including increasing decentralization, red tape, and weak communication.

On April 23, WHO advised against all but essential travel to Toronto, noting that a small number of persons from Toronto appeared to have "exported" SARS to other parts of the world. Toronto public health officials noted that only one of the supposedly exported cases had been diagnosed as SARS and that new SARS cases in Toronto were originating only in hospitals. Nevertheless, the WHO advisory was immediately followed by similar advisories by several governments to their citizens, and Toronto suffered losses of tourism. Also on April 23, Singapore instituted thermal imaging screens on all passengers departing from its airport, and also stepped up screening at points of entry from Malaysia. Taiwan's international airport also instituted SARS checkpoints with an infrared screening system similar to Singapore's. The last SARS case in humans was reported June 2003, though the virus may remain in animal hosts.

Net Assessment

It took more than three months from first information about the disease to a global alert. It was then another month until the virus was clearly identified. The time delay may have had something to do with China's dissembling about the extent of the disease, but it also demonstrates that the cause of any outbreak—whether natural or terrorist—may take some time to identify. Once identified, virtually every health care professional in the world became a potential collector of intelligence on the disease. Moreover, the world has had the good luck of recently getting to practice pandemic monitoring initially on a disease, SARS, that was not too easily communicated and then on another, H1N1, that was not very lethal.

Summary

Characteristics of the policy approaches taken in these suggestive cases are summarized in Table 3.1. The table indicates whether the initiatives had significant results and then compares the cases on other dimensions that seem relevant to success for any major initiative. Did visible events play a role in increasing international political will? What was the nature of the process? Were financial incentives important? Was technological change or the role of the private sector, especially the for-profit sector, critical? Was the target relatively specific?

For the most traditional of approaches to global problems—formal international negotiations—the implication is straightforward and is demonstrated by the contrast between Montreal and Kyoto: the likelihood of success increases with the fewer the participants, the more specific the target, the more that technology provides an affordable solution, and the fewer potential free riders who need to be bought off. Since these conditions do not apply in many circumstances, other approaches need to be considered.

The selection of cases contains lessons and warnings. Not all were failures. For major emerging diseases, international cooperation has been increasing, and in the two recent incidents, the world has been lucky in addition to effective. For water scarcity issues, there have been two principal international instruments: negotiations among river basin countries and ad hoc responses by coalitions of the willing to deal with the security consequences of conflict driven at least in part by water scarcity. River basin negotiations can succeed, as the Indus case

Table 3.1
Evaluation of Suggestive Cases

	Indus Waters Treaty	Drought in Ethiopia	SARS	Montreal Protocol on CFCs	Kyoto Protocol
Initiative(s) had significant impact	Yes, even with bilateral tensions	Yes, but very negative	Yes, negative on tourism and business but positive on controlling spread; international cooperation slow	Yes	No
Visible events increased political will	Yes (threat of cutoff, prospect of projects incentives)	Yes, but limited (media, NGO reporting of suffering)	Yes (visible spread of cases, quarantines)	Limited (expanding ozone hole)	No
Nature of process	Bilateral negotiations mediated by World Bank	Really none, only humanitarian groups	Networked communications	Formal international negotiations	Formal international negotiations
Financial incentives important	Yes, especially compensation to Pakistan	Apparently not significant	No	Yes, to buy off free riders	Insufficient
Technology or private sector key	No	No	No	Yes, new technologies replaced CFCs	Private sector opposed
Target was specific	Yes, demarcated set of rivers	No	Yes, but took time to identify	Yes, relatively few companies impacted, and all equally	No

demonstrates, for reasons akin to Montreal: the incentive to agree is powerful, and the parties are relatively few. For climate change, the principal international instrument—broad, formal negotiations—seems clearly unworkable. The determination of the poorer countries to free ride—and the arguments for letting them do so along with the very high price of side payments to compensate them for participating—only provided justification for other countries to emulate them.

From "Fixing" to Adapting and Beyond

Policy approaches toward the three challenges might be thought of in four clusters, roughly along a continuum from centralized to decentralized and from government dominated to private-sector driven. The first two—formal negotiations and coalitions of the willing—are familiar and so can be discussed and illustrated briefly. The other two, transcommunity networking and anti-fragile approaches, require more explanation and will be the focus of this section. Figure 4.1 depicts the four along continuums of approaches to policy and solutions, moving from what we call regulating to enabling policies, and from "fixing" to adaptive solutions and beyond.

We discuss each of these policy approaches in turn. Note that the alternative, enabling approaches to policy outlined in this chapter are worth considering whether or not national

Figure 4.1
Four Clusters of Solutions and Policy Approaches
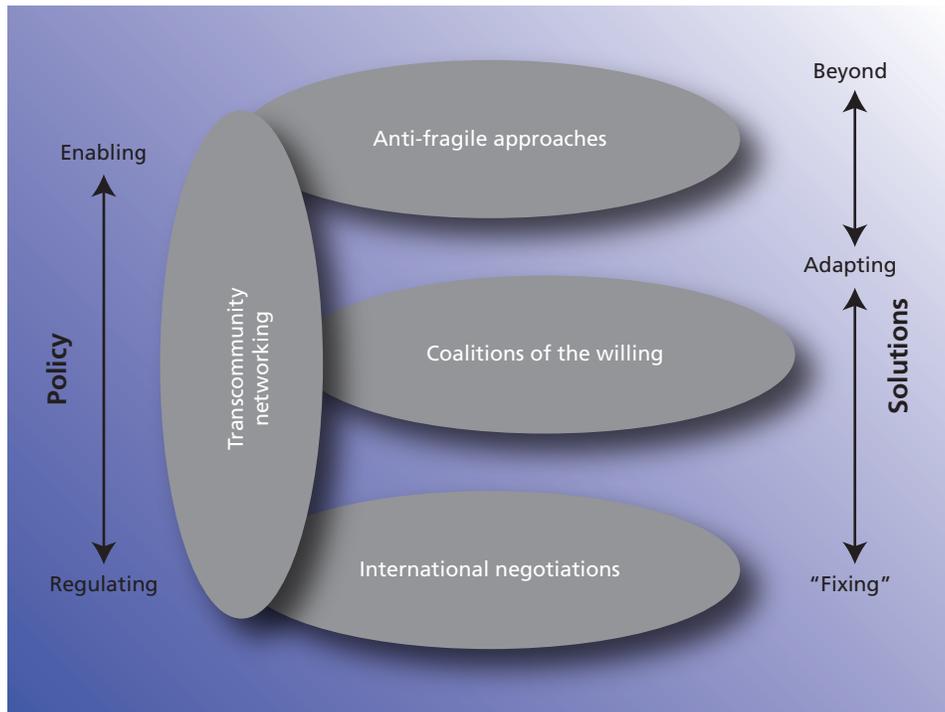
security is regarded as the driver. What the national security dimension does to these three issues is add urgency to thinking of new ways to address them. Moreover, the alternative approaches require government to act in different ways. "National security" usually means top-down action. For the alternatives, the government is the enabler, not the enactor; its role is adjusting regulations that stand in the way of alternatives, and tempering the force of lobbies wedded to legacy approaches.

Formal International Negotiations

At the centralized/government end of the policy continuum are traditional international negotiations aimed at binding treaties, such as the Montreal and Kyoto processes, as well as the Indus River basin negotiations. Those seek to solve the challenge of the commons by regulating and providing incentives for nations to behave for the collective good. Formal negotiations are usually restricted in participation (limited to states) and regulatory in approach. Centralizing both the description of the problem and the solution, as they do, has an intuitive appeal. For example, Kyoto simplified the problem of climate change to levels of GHGs and the solution to reducing those levels. Yet, the intuitive appeal of centralized definitions and the historic precedent of nation-to-nation discourse often belie the complexity of both challenges and solutions to threats to the global commons. They typically are easier with fewer participants and considerable shared interest. They require national leaders who both grasp the issues and are politically able to balance national interest with cooperation.

Coalitions of the Willing

Coalitions of the willing require just that, willing participants. They, too, are often coalitions of nations, but private sector organizations participate as well. That is noteworthy in health, where the Gates Foundation spends more in Africa than WHO. Participants are driven by self-interest and collective purpose in different proportions. Such coalitions have become a standard operating mode for NATO and for UN peacekeeping. In both cases, the existence of the institution provides some infrastructure for the action, both tangible and in terms of international authorization. Notice that Kyoto became, in effect, a coalition of the willing—of those nations that opted in.[1] As indicated in Figure 4.1, coalitions of the willing overlap with other policy approaches, depending on the goals of the coalitions and their methods of operating.

Kyoto drifted from being an international negotiation to a coalition of the willing mostly because the free-riding problem was insoluble. But notice that formal negotiations require nations to say "yes" or "no." Forced to do so, China had to say no. But "no" is surely not the real Chinese answer; rather it is probably "yes, but not yet" or "yes, but only in our own way," for China knows that its current track of increasing dependence on fossil fuel, especially coal, will bring short-term riches only at the price of long-run ruin to its own environment. This is demonstrated by its aggressive alternative energy programs.

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[1]   While the coalition does not include the United States, it does include many U.S. states, several of which have cap and trade systems in place or in preparation. Thirty some states have renewable energy standards. Hundreds of cities have GHG emissions targets and reduction implementation plans.

Coalition members are willing, if in different degrees, because measures to address climate change make sense for other reasons (Purvis, 2010). Stricter energy efficiency standards for vehicles, for example, lessen dependence on imported oil, a potential national security benefit. Replacing inefficient coal-fired power plants saves lives by improving local air quality. Public funding to spur innovation in clean energy technologies creates jobs and improves trade balances. Reducing deforestation helps minimize natural disasters and empower indigenous peoples.

As a result, the real action shifts from formal gatherings, like Copenhagen in 2009 and Cancun in 2010, to the margins of those gatherings. The focus shifts from international agreements to national actions. The approach is less top down and more bottom up. And the more that nations, their businesses, and their nongovernmental organizations can share information about what works, the better. The nations of the European Union, for instance, are well on their way to meeting their Kyoto commitments.

The international cooperation in the instance of SARS is a kind of coalition of the willing. WHO and national health authorities provided some infrastructure, and the coalition worked well because national interests were, in general, aligned with collective international ones. Indeed, national actions to detect and isolate infected individuals carried a positive spillover for other nations. In the case of pandemics, free-riding takes the form of deceiving the world about the extent of national infection, hoping to avoid economic costs in tourism, trade, and the like, while others subdued the epidemic. China displayed some of that free-riding in the SARS case but only for a while. It may be, moreover, that increasing transparency is making that form of free–riding harder.

The challenge for coalitions operating to prevent or rescue failed states, which may have failed in considerable part through water scarcity, is summoning the will. For an international coalition, acting earlier is almost always better, but at that point the conflict or failure still may be "iffy" and so suggest a kind of negative commons problem: why act now if action may be unnecessary? By the time action is visibly necessary, it may be too late or more dangerous or both (George and Holl, 1997). That seems to have happened in the instance of Ethiopia and its pastoralist migrations.

Transcommunity Networking

Crafting policy to solve complex issues like climate change requires bringing a range of perspectives to bear. Identifying and integrating a large pool of perspectives, however, takes time. Accordingly, a third policy approach would create an infrastructure for the exchange of knowledge toward sustainable practices, instead of determining and imposing solutions. It might be thought of more as an enabler of policy ideas than an approach on its own. Distinct from coalitions of the willing, transcommunity networking includes interaction between actors outside nations and organizations. This cluster is not necessarily decentralized; rather, centralization would shift from attempting to regulate behavior to facilitating communication in the interest of inducing behavior that mitigates current threats and reduces the risk of future ones. In that sense, while the Intergovernmental Panel on Climate Change is governmental in structure, it operates as a network for sharing scientific data and ideas.

In the domain of transcommunity networking, three kinds of communities and corresponding networks lend themselves to enabling policies.

- **Local communities and market networks.** Individuals who live in close physical proximity naturally form communities for social interaction, security, and commerce. Policy that supports localized distribution of food, manufacturing of goods, production of energy, and conservation of natural resources would facilitate the development of resilient communities. Coordination between communities would efficiently distribute excess capacity in any of the four areas, and access to the Internet would facilitate coordination. To that end, improving the digital infrastructure necessary for resilient communities would help them transition in this direction.
- **Technology communities and "open source" exchanges.** Engineers and scientists who work within a specific technology (e.g., software engineers) have realized the value of open collaboration. The origin of the World Wide Web serves as an example (CERN, 2008). The goal was increasing the ease of exchange and display of data among scientists; the means was developing ways to create and access web pages. The web then grew exponentially, demonstrating that the means was very versatile in sharing data far beyond the scientific realm. The Internet now serves as a medium for the collaborative development of software (e.g., Linux) and web-based applications (e.g., Wikipedia). Policy that maintains open access to the technologies of the Internet and that supports the development of publically accessible resources, like social media, enables networks for sharing technology (Landler and Knowlton, 2011).
- **End user communities and social networking.** Adoption of best practices remains a critical a factor in managing threats to the global commons. End users who choose to adopt particular solutions create communities with the potential to popularize best practices. For example, people who choose to drive hybrid cars, take public transit, or ride bicycles define transnational communities for best practices in alternative transportation. Virtual spaces in which the members of a community can congregate have the potential to attract new members and thereby increase adoption of a particular solution. Web-based social networking provides a platform for virtual spaces in which transnational coalitions of the willing can form.

Notice that this approach can be applied to all three threats. For example, information sharing was a key component of a discussion of European Union pandemic preparedness (Dowdall, 2011). As the three issues suggest, information is not meant to be restricted to central governments. Local areas or individuals can draw from the information pool to improve community resilience at all levels. For example, a region within a country may use vulnerability assessment tools to realize increased susceptibilities to extreme weather events, and develop local resilience accordingly, while another region may develop resilience in response to an increased threat of water insecurity.

Anti-Fragile Approaches

The fourth cluster, anti-fragile approaches, is inspired most recently by the work of Nassim Taleb.[2] For him, common language that uses "robust" or "unbreakable" as the opposite of

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[2]   This work is thus far unpublished but discussed in an interview with *The Economist* and on his website. For the former, see "The World in 2036: Nassim Taleb Looks at What Will Break and What Won't," *Economist*, November 22, 2010.

"fragile" is wrong. Rather, the opposite of fragile objects would be ones that *benefit* from shocks that would destroy fragile things—thus "anti-fragile." If antibiotics do not kill bacteria colonies, they make them stronger as resistant strains survive and multiply. Antibiotic-resistant bacteria, therefore, are anti-fragile. So are muscles, which become stronger through use and strain. In general, individual humans are relatively fragile, while the process of evolution is anti-fragile, as it thrives on disorder and randomness.

Just as nothing is perfectly fragile, nothing is perfectly anti-fragile, as the bacteria example indicates. Things are anti-fragile across some range of shocks. Too much strain on muscles can damage them, not make them stronger. Taleb does not use the example, but learning organizations aim to be anti-fragile. Some mistakes or external events might put them out of business, but less dramatic mistakes or surprises should make them stronger as they learn from mistakes and find opportunities in surprises. The market can also be seen to represent anti-fragility to the extent that new firms leverage new innovations that put older firms out of business but make the overall economy stronger.

Taleb argues that our language's lack of a term for anti-fragile systems reflects a human cognitive bias to cling to the status quo.[3] Being open to anti-fragile logic serves as an antidote to what seems a deeply rooted human tendency to think in terms of preserving things as they are, or returning to a familiar state, rather than being open to modifying the parameters of a problem in order to reach a new, preferable state. We conceive of policy as "fixing" a problem much as we fix a broken plate—returning it as close to its previous state as possible. That was the logic of Kyoto, what was called "mitigation"—that is, reducing GHG emissions in an effort to restore a previous status quo. Hence, Figure 4.1, in laying out the four approaches, includes a continuum from "fixing" to adapting and beyond.

The characteristics of an anti-fragile human system are demanding. It must profit from adversity. From the perspective of the commons problems, an anti-fragile approach would search for alternatives that could attract new participants, scale to accommodate those new participants, and then perform as well as or better than the legacy system. In this way, the system could create a positive feedback loop that would make the system better over time as the legacy system suffered more disruptions. This bottom-up approach might be thought of as "tinkering."

A system that offers multiple benefits can increase its power of attraction because potential adopters will value different benefits differently. The need for multiple benefits has long been a challenge for those promoting global health, who found they had to make the case both that it was right and that it produced economic benefits.[4] For example, if an alternative system for producing and distributing energy were both cheaper and emitted no GHGs, then it would attract people who cared a lot about the environment while also attracting those who cared less but were very sensitive to price.[5] Multiple benefits expand the number of potential reasons

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[3] Other cognitive biases, such as the availability heuristic, have been demonstrated through experiments (see Ariely, 2009).

[4] For a landmark study, see Institute of Medicine (1997).

[5] A refinement to this point is the recognition that there are different types of price risks. If an alternative system costs slightly more than the legacy system (at first, at least) but then price was highly stable, it is possible that highly risk averse individuals would prefer the new system to the legacy because the price premium served as a kind of insurance on uncontrollable shocks that would cost them money. Bill Gates (2010) makes a similar point. He wishes for an economical and environmentally neutral solution to our energy needs so that climate skeptics can buy into it for economic reasons without changing their assessments of climate change.

people could have for joining, thus attracting not just climate change skeptics but also individuals concerned about other policy issues, such as U.S. dependence upon foreign oil (Carter, 2006; Crane and others, 2009).

Dynamics of the Clusters

As depicted in Figure 4.2, policy can evolve from setting regulations to enabling innovative solutions. The upper-left corner represents the potential for innovation afforded by increasing accessibility of technology. Essentially, more participants increase the chance of developing innovative solutions. The lower-right corner represents the potential of autonomous solutions to lead to cooperative policy. Instead of compelling nations to comply with regulations, policy could enable communication within and among coalitions of the willing. (See Appendix A on the evolution in computing as a metaphor for four approaches to policy.)

In the progression from international negotiations to coalitions of the willing, nations autonomously apply solutions to counter local consequences of global threats. Policy that enables transcommunity networking lets expert communities share solutions across nations and end-user communities to exchange experiences in order to develop best practices. The combined effect of shared innovation and autonomous adoption of solutions creates a shift from a top-down to a bottom-up approach to policy. As represented by the left-to-right diagonal region, policy that evolves from imposing regulations to enabling networking fosters a range of solutions to global threats, from fixing, to adapting, to "beyond" solutions that actually capitalize on, not just adapt to, global threats.

To be sure, the four policy approaches are neither discrete nor independent. They are a continuum, and policy toward any particular issue might include elements of several. Moving up the diagonal in Figure 4.2, as initiative moves from top-down to bottom-up and as government moves from enactor to enabler, the approaches come to describe qualities rather than denote strategies or if-then instructions. Formal negotiation is a strategy that governments can use or not use. Coalitions of the willing can be the strategic choice of a would-be coalition builder, but they can also, like Kyoto, describe a quality of interaction among participants. Transcommunity networking, and to a greater degree anti-fragile approaches, lie toward the enabling end of the continuum and so are much more descriptions of policy architectures than buttons to push. The continuum is also dynamic in that anti-fragile approaches that prove themselves may set new standards for regulation and reset the benchmark for innovation.

An Example of an Evolving Approach

The Kyoto-as-coalition-of-the-willing approach to climate change lies toward "fix it" in the solutions spectrum. It seeks to multiply arguments for reducing carbon emissions and share best practices for how to do so. But these tend to rest on traditional approaches to fixing through reduced production of GHG emissions.

A different approach to fixing, though, is emerging. Geoengineering solutions to climate change come in two broad forms.[6] The first, carbon dioxide removal (CDR) technologies, are

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[6]   This entire section draws heavily on Lempert and Prosnitz, 2011.

Figure 4.2
Evolving Policy Approaches
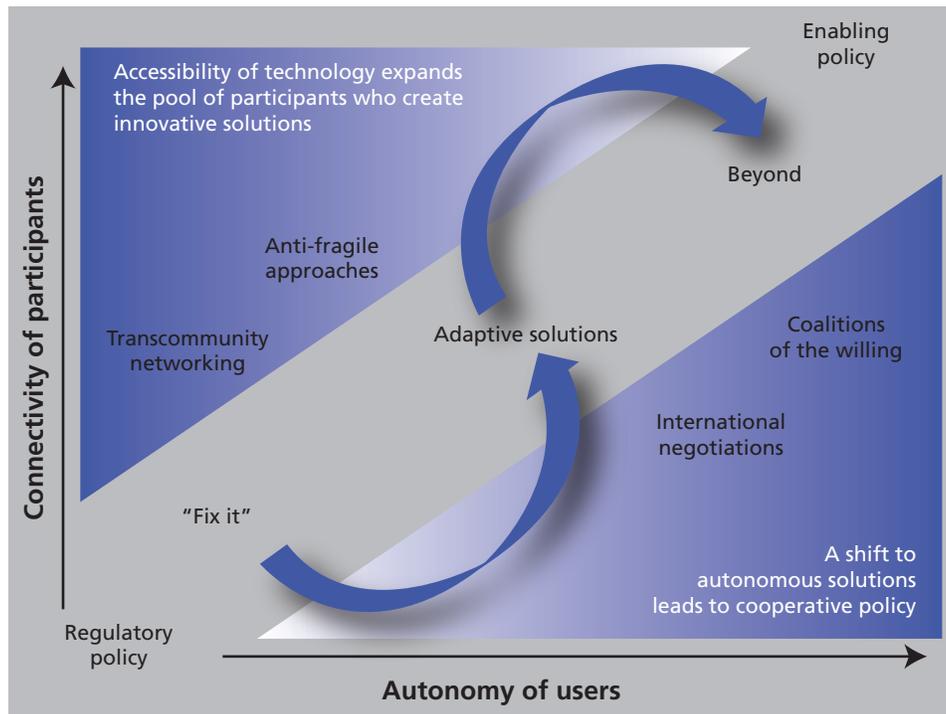
RAND *OP360-4.2*

part of the menu of the fixing approaches. However, instead of reducing GHGs coming out of power plant smokestacks, they seek to extract CO_2 directly from the atmosphere and then store it in some type of reservoir. CDR approaches are as simple as reforestation, growing new trees that extract and store carbon. Although that approach is simple and inexpensive, and has other environmental benefits, alas, it does not store much carbon by comparison to the total of fossil fuels being burned (Royal Society, 2009).

Another CDR approach is ocean-iron or ocean-nitrogen fertilization. Iron compounds would be added to regions of the ocean in order to stimulate growth of phytoplankton that absorbs CO_2 and transfers it to the deep ocean when the organisms die. The rub with this approach is that initial tests have not been promising (Lempert and Prosnitz, 2011). Other CDR approaches seek to accelerate natural, but long-term, processes such as removing CO_2 from the atmosphere through the weathering of carbonate and silicate rocks. Finely ground silicate materials, for instance, could be added to agricultural soils to absorb CO_2 from the atmosphere. This approach could be effective but would be costly and might have as-yet-not-understood effects on agricultural soils (House and others, 2007).

Most of these CDR approaches, like other "fixing" approaches to limiting GHG emissions, are slow to have much effect. That said, they would not appear to pose security issues, and they could be implemented by a single nation or willing coalition. Yet if, in the end, this form of fixing does not prove much cheaper than approaches to fixing by limiting GHG emissions, it will be beset by the same temptations to free-riding that made Kyoto stillborn. CDR

might still be part of a portfolio of climate change approaches by playing a role in a cap-and-trade system. Reforestation projects have already been funded under the Clean Development Mechanism defined in Article 12 of the Kyoto Protocol.

By contrast, the other family of geoengineering approaches, solar radiation management (SRM), poses more daunting challenges to institutions and relations among nations. SRM seeks not to limit GHG emissions or extract them from the atmosphere but to offset their effect by reflecting solar radiation back into space. SRM techniques have the potential to make an impact quickly, and can be reversed. They, too, range from the simple but not very effective—like brightening the earth's surface by painting roofs white—to the more dramatic, which will have greater impact but also greater risk. One such dramatic approach would increase reflection by injecting sulfate particles into the lower stratosphere. The effects would be similar to those of large volcanic eruptions; Mount Pinatubo in 1991, for instance, cooled the earth by about 0.5 degrees Celsius for about two years. This approach seems feasible, requiring a few million tons of sulfur per year—on the order of the cargo carried by the Berlin airlift of 1948–1949—and costing tens of billions of dollars per year, a fraction of the estimated cost of reducing GHG emissions (Lempert and Prosnitz, 2011).

Another SRM approach would whiten the low-level marine clouds that cover about one-quarter of the earth's ocean surface by spraying those clouds with fine particulates that would serve as nuclei for condensation. Still another approach would emplace reflectors either in near-earth orbits or at the point (about 1.5 million km from earth) where the gravitational attraction of the earth and sun balance (Lempert and Prosnitz, 2011).

For the SRM family of approaches, cost may be a factor, especially for reflectors, but unanticipated side effects are a greater concern. For instance, studies suggest that Mount Pinatubo's eruption led to much less precipitation over land areas and about a 2-percent reduction of stratospheric ozone levels. Initial model simulations suggest that sulfate geoengineering could have similar effects. In addition, neither the effectiveness nor the side effects of cloud whitening and reflectors are well understood (Lempert and Prosnitz, 2011). The SRM family is not an anti-fragile approach, but it does rest on the recognition that a solely emission reduction solution is impossible, and thus that adapting to new circumstances is imperative.

This next set of approaches to climate change moves away from fixing, evolving toward adapting and mitigating the worst consequences. While adapting is still pretty direct in approach, it does broach the premise that the previous status quo is gone beyond recovery. Adaptive approaches come in modest and more dramatic forms.

For most countries, especially the richer ones, the responses to climate change will be adaptive even as they seek to reduce emissions. Human beings already adapt to a wide range of seasonal climates. Thomas Schelling—friend, colleague and Nobel Prize-winning economist—observed many years ago that he experienced more climate change during a business trip from Cambridge, Massachusetts, to Washington, D.C., than the country as a whole would experience in decades. Adaptation will take a variety of forms at home, and will extend to actions abroad—again, in a loose coalition of the willing.

At home, the menu of policies will likely include new standards and building codes to cope with rising sea levels, more violent storms, and increased risk of fire in drier areas. Insurance policies will both drive and be affected by those standards, as insurance for, say, coastal properties becomes more expensive or unavailable, and in any case is conditional on owners taking a range of protective actions. Physical protections of all sorts will be on the agenda.

Given their tug on America's heartstrings, farmers displaced by changing climate are likely to be a particular focus of attention. Abroad, too, the focus will shift to adapting—with, for instance, aid policy shaped to help foreign farmers switch to crops compatible with their altered climate. And the list could go on.

Illustrations of Anti-Fragile Approaches: Beyond Adapting

The following ideas across the three issues are meant to illustrate the implications of an indirect, anti-fragile approach. They employ a bottom-up, "tinkering" mechanism instead of a top-down, centralized mechanism. Government would have a supporting role in facilitating the growth of these systems, by modifying subsidies, regulations, and policies, but the driving force behind the growth of these systems would be individuals and communities. Not all of these ideas are new, though some familiar ones are being newly enabled by advancing technology. These policy ideas are a long way from providing a "Solution" with a capital "S" to any of the three challenges. The main reason is the uncertainty of whether they can scale enough to make serious dents in the three threats.

Climate Change: Local Fabrication Using Three-Dimensional Printing

Three separate strains of customized production methods have begun to converge to offer new possibilities. Rapid prototyping machines, which can fashion rough prototypes out of plastic, have existed for more than two decades but have been expensive (Wayner, 2007). Now, prices are falling while the machines are getting better. As a result, businesses have begun to use them not just to build prototypes but to produce highly customized products for consumers (Vance, 2010). Meanwhile, numerical control systems have also continued to improve, becoming capable of more flexibility, smaller sizes, easier user interfaces, and more rugged designs. These two strains of fabrication technology have been exploited by U.S. Special Operations Command (SOCOM) to develop a Mobile Technology Complex (MTC) that can fabricate replacement parts out of basic raw materials and computer-aided design (CAD) files (Strategy Page, 2010). For SOCOM, this new capability is useful for items not currently in production or in short supply for whatever reason.

A third strain of fabrication technology is open source, personal three-dimensional printers, also called "makers" or "fabbers" (Steele, 2007). These rudimentary systems have been developing rapidly at prices within the reach of individual consumers. For example, MakerBot Industries' Thing-O-Matic 3D Printer Kit costs $1,250, is compatible with home PCs, and can fabricate objects using durable plastic (MakerBot). In many ways the current situation is akin to the early days of the personal computer; personal three-dimensional printers are less capable than industrial rapid prototyping machines and are aimed at a niche market of hobbyists, but they are getting better fast, due in part to continuing advances in computing power, and could become a truly "disruptive" innovation in the sense of enabling dramatic new possibilities (Christensen, 1997).

Indeed, several decades hence, the MakerBot and RepRap of today might be seen as today's equivalent of early personal computers like the IBM 5110 and the Apple II. In fact, these 3D printers could be even more important than the early PCs if they usher in not just a new market but also an entirely new model of production. While it is fair to question how

much and how quickly this idea could scale up, that issue is put into perspective by noticing how easy it is to scale this 3D "printing" by comparison to contracting with a publisher, still less a manufacturer.

Such advances make it possible to imagine future manufacturing that involves significant local and customized production and has as much to do with manipulating information as materials. Online platforms could function like an iTunes app store, except that they would be for physical products. Consumers looking for new products would connect with designers selling their designs. As the CAD skills of the average consumer improved, they would be able to customize designs they acquired, fostering still more innovation through "tinkering."

This local fabrication system could attract new participants while facilitating continual incremental improvements, enabling it to not just survive shocks that would damage the legacy production system but actually get stronger during those shocks; during supply chain disruptions, individuals able to fabricate products would profit by selling to their neighbors products printed from designs downloaded from the web. As this system spread, it could indirectly reduce the need to ship finished products, reducing the GHGs emitted in the process of moving goods from factory to consumer. However, the net effect on carbon emissions is not clear, depending on the emissions involved in transporting raw materials and of local production methods versus traditional manufacturing.[7]

Climate Change: Local Smart Grids and Local Power Production

Producing energy, especially with coal, is a major source of GHGs. There has long been interest in individuals or communities investing in local renewable energy generation capabilities, such as rooftop solar panels or micro wind turbines. As those become most cost effective, and if they were connected to a local smart network with the ability to store excess energy production, they would enable local electricity to be used or sold back to the grid if it were not needed locally or used when local production falls at night. The pieces would be in place for a local energy system. Local power generation is already technically feasible.[8] Smart grid technologies being demonstrated can handle the two-way, dynamic flows created by the variable character of renewable power sources, as well as the real-time metering necessary to measure when consumers are using energy or selling it back to the grid (Homeland Security Newswire, 2011c).

Power could be shared over a local power grid which could be intermittently connected to the larger, national grid.[9] During normal operations, the larger grid could provide the assured power necessary to meet baseload demand.[10] While the cost to produce local energy might

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[7]   For a balance sheet on the "greenness" of 3D printing, one that reaches a positive conclusion, see Campbell and others, 2011.

[8]   See, for example, the variety of containerized solar and wind generation systems produced by Skybuilt Power (http://www.skybuilt.com/news/pdfs_products/SkyBuilt_SkyStationTechnicalSheet.pdf). There are also local solar generation solutions currently being demonstrated by the Marine Corps in Afghanistan (Homeland Security Newswire, 2011b).

[9]   John Robb (2008a) has discussed the usefulness of "microgrids" as a key component of resilient communities. A microgrid would "essentially be a local power network connected to the national or regional grid by a smart switch." The microgrid provides a "local network (electricity plus data services) that can become a platform for the organic growth of a diverse and innovative ecosystem of solutions and providers."

[10]   Other innovations, such as travelling wave reactor technology, currently being publicized by Bill Gates, could offer ways of providing safe, carbon-neutral baseload energy for the grid ("Thinking Small," 2010; Wald, 2009; Gates, 2010).

be slightly higher on a day-to-day basis, that additional cost could be recovered if local power could be sold at a premium or simply used personally during disruptions to the larger grid.

In this way, the participants in this local electrical power generation platform would be positioned to survive during shocks that harmed the fragile, legacy system. Note that while the motivation for opting into this platform could be driven by purely practical desires—to be protected from rising energy prices or insulated from outages—the result could be beneficial in reducing the production of GHGs and thus addressing climate change.

Climate Change: "Passive House" Design

One-third of energy-related carbon dioxide emissions are generated by energy use in buildings (Giles, 2007). "Passive house" design might radically reduce the energy required to regulate temperature in homes and offices. By traditional economic logic, energy efficiency improvements have decreasing marginal returns and, thus, will not lead to radical changes in system structure. However, Amory Lovins has pointed out that the logic fails to hold if houses can be so insulated that they no longer need a central heating and cooling source (Hawken, Lovins, and Lovins, 1999). Special fans exchange air without transferring heat to achieve radical reductions in the amount of energy required to heat and cool these "passive houses" (Giles, 2007). The cost savings from having neither furnace nor fuel could dwarf the costs of super-efficient insulation and windows. Lovins refers to this phenomenon as "tunneling through the cost barrier" (Hawken, Lovins, and Lovins, 1999).

While capital requirements are barriers to opting in to this model at present, over time an awareness of the benefits could spread, leading to new metrics for valuing homes and opening up new avenues of financing for these transformations (Robb, 2008b). On its own, this system may not be as anti-fragile as the previous two examples, but the discussion of resilient communities will illustrate the synergies of it as part of a larger system. As with the other examples, this new system would lessen the amount of GHG emitted.

Water Scarcity: Rainwater Collection

The concept could hardly be simpler: collecting rain in any receptacle, large or small. It is very easy to implement in a developing country because the only infrastructure required are containers to store water. Any individual or household can become an agent of water storage. The collected rainwater can be used for personal consumption or to recharge water sources, which can arrest saltwater contamination of groundwater sources in coastal areas (India Together). In addition, the marginal benefit to rainwater collection in a developed country should be greater the more it starts from a higher level of infrastructure, such as the ability to store rainwater longer or pool neighborhood resources more easily to increase water insurance.

This very prosaic approach meets some of the criteria of an anti-fragile system. Of course, it is not perfectly anti-fragile, nothing is; it would not be much help in prolonged drought. It is, though, a "tinkering" method and could scale. Individuals can opt in at any time without requiring more infrastructure or placing demands on the system: my decision to start collecting rainwater does not infringe on your ability to collect, too. Agents currently engaged in collection can easily design new systems to increase the efficiency and volume of collection. As a concept, rainwater collection is very flexible; methods can be modified for urban and rural needs, and can be ecoregion specific (Rain Water Harvesting). Thus rainwater collection allows for "tinkering" at the individual, region and even national levels.

As with local power generation, individuals could reap benefits by joining the anti-fragile system for a variety of environmental or altruistic reasons, while the system as a whole is also strengthened. Those concerned about the water table, for instance, should be supporters of collection, at least to the extent that rainwater not collected is simply lost in runoff. While such a system would not guard against severe or prolonged shortages, it could provide temporary relief when a disturbance to the standard water system causes a water shortage. Such relief can give national governments more time to implement a comprehensive solution. In places that will likely experience a very uneven distribution of water throughout the year as a result of climate change, this approach will allow for more effective management of the resource, acting as a form of insurance.[11]

Pandemics: Detection

It is harder to conceive anti-fragile ideas for pandemics because, after all, the point is precisely to "fix"—to protect the existing status quo from devastating disease. Yet detection represents an aspect of anti-fragility. Techniques that enable detection despite political concerns and social stigma contribute to an anti-fragile approach. For example, smart phones and social networking provide a medium through which health care professionals could spontaneously serve as collectors of intelligence on the spread of a disease. In the cases of SARS, once the disease was identified, every medical person in the world became a collector of intelligence on the outbreak.

All Three: Resilient Communities

All these ideas can be useful on their own, but in combination they could not only reduce GHG emissions but also improve resilience in the face of natural disasters, terrorist attacks, financial crises, and even disease. For example, an electrical smart grid could, when combined with local power generation, mitigate some of the risk posed by a terrorist attack that tried to create cascading failures in the national grid. Such a grid would also be more resilient in the face of natural disasters and could help mitigate disruptions caused by quarantines and travel restrictions produced by a serious pandemic.

Such "resilient communities" would be able to "operate autonomously regardless of availability, pricing, or quality of external goods/services for extended periods of time" (Robb, 2009). A resilient community would seek to be able to provide for its essential needs—water, food, energy, and essential products—while limiting the need for trade either domestically or international. Surely, normal commerce would not stop altogether; rather, there would be floors below which community members could be confident their standard of living would not fall indefinitely (Robb, 2010).

Note the synergy among these systems. Local fabrication using 3D printing technology could produce some replacement parts for a wind turbine during an emergency that shuts down global supply chains, for example. Passive homes would require significantly less energy to regulate temperature than legacy homes, reducing the amount of power required to meet these needs, freeing power to be sold outside the community or used within it to run, for

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[11] India is one country that has started to incorporate rainwater collection in its portfolio of water scarcity strategies, but adoption has been slow in other nations. An extension of this concept would be wastewater recycling, especially for areas that continually fall short of receiving required precipitation levels. USAID has implemented such a program in Jordan, with resulting gains in agricultural yields and reduction in groundwater use (WaterWiki.net).

example, three-dimensional printers. Put together, the ideas suggest the possibility of new anti-fragile social systems that would not sacrifice quality of life but would emit far less GHGs as a byproduct. If participating in the system cost marginally more than the legacy alternatives, participation could still make sense if the alternative provided the option to survive during or even profit from periods of instability. Participating would be like buying insurance against a high-consequence event.

However, standing in the way of these new platforms are sure to be some existing government regulations regarding power distribution, zoning requirements, and the like. At least some stakeholders in legacy systems, such as centralized power generation and distribution companies, will use laws and regulations to prevent new competitors from arising. The challenge will be to adjust these conditions so that decentralized, market-based approaches have a chance.

Considering anti-fragile approaches from the perspective of poor countries—the ones most likely to suffer direct security effects of the three threats—manifests special challenges: although developing nations do not have the large networks of infrastructure that developed countries take as a given, this means that they also have fewer stakeholders in legacy systems. Much of Africa, for instance, has all but bypassed landline telephones now that cell phones are cheaper and more reliable, and portable solar technology is bringing health care, education, and other social services to underserved and previously unserved villages (Elephant Energy; Lift Up Africa; WE Care Solar).

Paradoxically, alternative systems may be easier to implement in places where legacy infrastructures are weak—and weakly supported by lobbies and regulations. Another appeal of anti-fragile approaches in developing countries is that local customs, which may have previously impeded the adoption of traditional policy options because they were suggested by "outside" institutions, can be overcome or simply bypassed under an alternative approach.

Conclusion

Almost by definition, global threats challenge traditional approaches to national security policy. The Middle East conflict and nuclear proliferation have proven immune to unilateral and multilateral action. Climate change, water scarcity, and pandemics, which are less visible threats most of the time, place a new set of demands on policy approaches. The mixed record of policies involving international cooperation demonstrates the challenge of finding solutions that effectively manage the long-term uncertainty of the three threats to the global commons. For example, while the success of the Montreal Protocol in managing ODCs demonstrated the potential for international negotiations, the limited effect of the Kyoto Protocol in managing GHG emissions drives home the need for an alternative approach.

Coalitions of the willing improve on international negotiations in that participating nations and groups realize immediate tangible benefits by complying with regulations and, as a result, voluntarily seek and apply solutions. The risk of free-riding and a tendency toward adaptive solutions, however, tend to restrain coalitions to living with a threat as opposed to mitigating risk. To push beyond the status quo, coalitions of the willing require innovation.: enabling transcommunity networking holds potential for coalitions to evolve from adaptive solutions to anti-fragile approaches that capitalize on a particular threat.

In varying degrees, each of the three threats resists a "fix it" approach and holds potential beyond an adaptive or "living with it" approach. Climate change, in some respects the most daunting of the three in policy terms, compels anti-fragility. In particular, resilient communities simultaneously could reduce GHG emissions and mitigate other security and economic risks as well. As the most regional issue of the three, water scarcity inspires local, anti-fragile solutions that derive from nature. For example, a beetle that harvests fog provided the idea for a personal water-collection device.[1] Pandemics are an obvious global security concern and therefore policy approaches benefit from international cooperation for containment and treatment, and also drive innovation in techniques for rapid detection. In the vein of anti-fragility, mobile telephones could be leveraged to turn virtually every health care professional in the world into a potential collector of intelligence on the spread of a disease.

An appreciation for and development of anti-fragile approaches requires a shift in thinking. In that sense, trying to move beyond "fixing" approaches is at least as important as seeking anti-fragile ideas. The "fixing" approach is pervasive in policy, from local to global. A striking example is how fragile U.S. and other nations' policies were in dealing with the "Arab spring" of 2011. For understandable reasons, those policies had sought stability (a "fixing" word) through autocratic Arab regimes. When demonstrations began, the policy debate was

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[1] See research inspired at MIT (Trafton, 2006).

precisely between fixing (trying to restore stability) and adapting (abetting change in the hope of more plural and decent regimes); policy moved only haltingly from the first toward the second. To be sure, fixing had its attractions lest Islamic radicals capitalize on the unrest. But that grasping for stability tended to cut off creative thought about how to take advantage of the opportunity afforded by unrest.

Thinking beyond fixing toward anti-fragility makes sense whether or not the three issues are regarded as threats to national security. The national security dimension simply adds urgency to looking for new approaches. Conceived of as an approach or mind-set, anti-fragility may offer advantages as particular security threats become more difficult to identify, assess, and target. The global nature, broad indirect effects, and interconnections of climate change, water scarcity, and pandemics characterize security threats that are elusive to centralized assessment and to policy that targets them individually. The simultaneous increase in global connectivity and autonomous decisionmaking poses further challenges for predictive risk assessments.

Anti-fragility capitalizes on the challenges by balancing self-reliance with a readiness for change. In principle, anti-fragile thinking does not succumb to, and perhaps even exploits, uncertainty. Considering anti-fragility can at least inspire innovation in policy approaches and holds potential as an alternative vantage point in an age of global threats without threateners. Notice that, in principle, anti-fragile approaches seek to turn the challenge of the commons on its head: rather than seeking to prevent states from acting on national interests in ways that hurt collective goods, they aim to provide individuals or groups with incentives to act in ways that are both in their narrow interest *and* ultimately advance collective interests.

In her biography of Nobel Prize-winning mathematician John Nash, Sylvia Nasar recounts a colleague's description of how Nash solved problems: "Everyone else would climb a peak by looking for a path somewhere on the mountain. . . . Nash would climb another mountain altogether and from that distant peak would shine a searchlight back on the first peak" (Nasar, 1998, p. 12). Attempting to solve a collective-action problem like climate change through negotiation and conferences is like looking for a path up a steep and formidable mountain. The global community has had difficulty scaling these peaks directly; perhaps it is time to consider indirect approaches to major threats to the global commons.

# Computing Environments as an Analogy for Policy Approaches

The evolution of computing provides an analogy for differences among the four clusters of approaches. The analogy is made graphic in Figure A.1. The era of mainframes evokes policymaking by governments through international negotiations. The paradigm of mainframes that confined access to computing resources resembles imposed regulations, ones constituting "a fix" for a problem. The Internet represents a policymaking platform through which nations and groups could decide individually how to participate and so form coalitions of the willing. The proliferation of personal computers and smart phones with access to the World Wide Web connects the computing metaphor to the approach cluster of transcommunity networking, in that social media exemplify open access to virtual communities. Finally, cloud computing, which leverages computing power, represents policymaking that has the benefit of a vast pool of perspectives that can be continually assessed to adjust solutions dynamically as anti-fragile systems.

The two corners of the figure represent advances in hardware and software that, in combination, led to evolution in computing environments. In the lower-right corner, the reduction in cost of hardware and advances in wireless networks expanded the range of users who could access the Internet with increasing spontaneity. Smart phones placed the capabilities of a computer in the palms of users, and the availability of mobile phones continues to increase in the developing world. In the upper-left corner, open architectures enabled a broader range of users to participate in the process of developing technology. High-level programming languages no longer required the expertise of electrical engineers, and point-and-click interfaces for publishing pages on the web allowed for the proliferation of personal websites. In addition to placing content on personal websites, users could collaborate through Web 2.0 to generate and vet content in applications such as Wikipedia.

The curved arrows represent the interplay between advances in hardware and software. The two advances enabled what might seem counterintuitive—a simultaneous increase of autonomy *and* of connectivity. Not only did wireless and mobile access to the web increase the connectivity of users, but an open architecture for development in technology facilitated applications (email, text messaging, social networking, and the like) around which an increasing number of autonomous users could coalesce. The combination of independent access to computing devices and collaborative development of the Internet permitted the evolution from what is characterized in Figure A.1 as hardware-regulated to software-enabled centralization. In effect, Figure 4.2 applies this logic to policy approaches.

Figure A.1
Computing Environments as an Analogy for Policy Approaches

Software-enabled centralization

Open architecture expands the pool of participants in innovation

Web 2.0

Cloud computing

Search engines

Smart phones

Web pages

Internet

Personal computers

Mainframes

Advances in technology increase accessibility of the Internet

Hardware-regulated centralization

Connectivity of participants

Autonomy of users
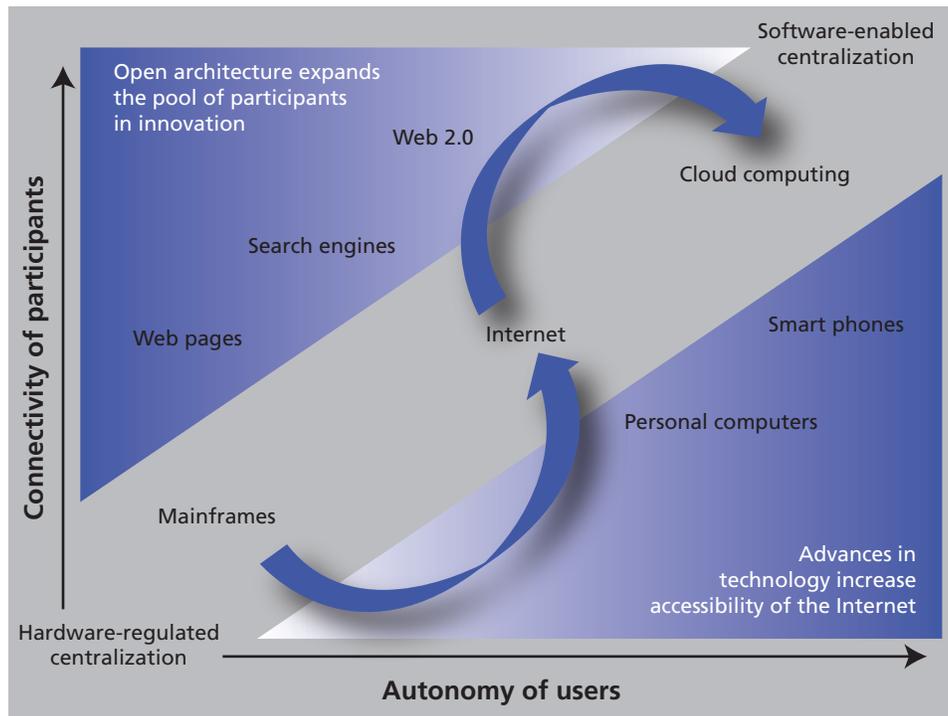
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